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SOLAR HEATING, COOLING, AND HOT WATER SYSTEMS INSTALLED AT RICHLAND, WASHINGTON

Prepared by

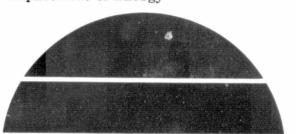
Engineering Olympic Corporation 3070 George Washington Way Richland, Washington 99352

Under DOE Contract EX-76-C-01-2404

Monitored by

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For the U. S. Department of Energy





# U.S. Department of Energy

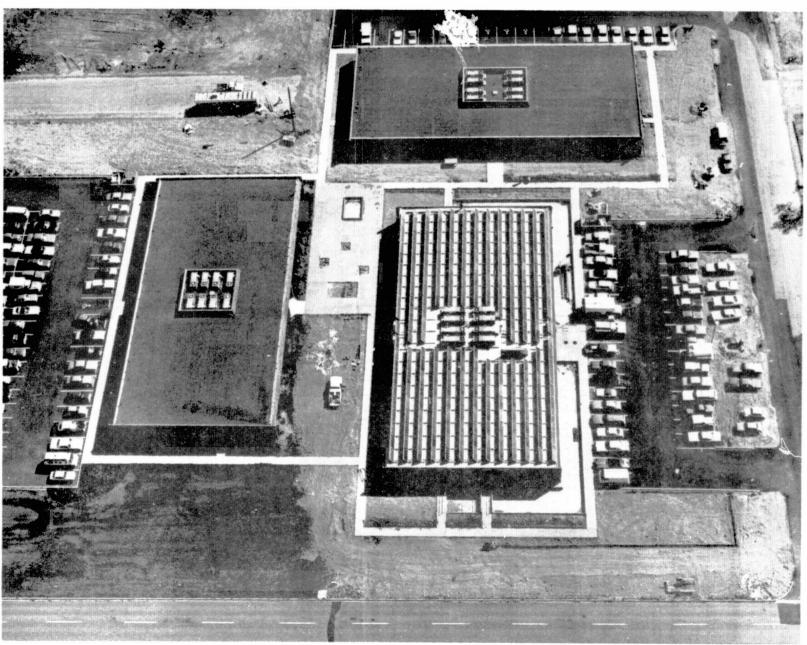


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#### 1.0 INTRODUCTION

Project Sunburst is a solar heating and cooling demonstration project being performed for the Department of Energy by Olympic Engineering Corporation. The project was organized by a joint effort of three small business firms based in the State of Washington. Olympic Engineering is the lead proposer and program manager, Development Dynamics Company of Richland (DDCR) is the building owner and Tracey-Brunstrom and Morgan Partnership was the architect engineers. General Electric also acted through its Space Division providing design, procurement, and technical support of the solar system.

Project Sunburst involves two nearly identical buildings at the same site in Richland, Washington. Building One, a control, is heated and cooled by conventional heat pumps. Building two, the demonstration, is provided with solar space heating/cooling and solar water heating by flat plate collectors mounted with heat pump backup. The demonstration solar system is instrumented and monitored by NASA at the Marshall Space Flight Center in Huntsville, Alabama. Energy use and solar collector system efficiency will be monitored and compared between buildings for a period of up to 5 years.

Contract EX-76-C-01-2404 between the Department of Energy and Olympic Engineering Corporation is essentially divided into 2 phases, the building construction and solar system installation phase, and the system monitoring and evaluation phase. This final report on Project Sunburst defines the work accomplished by Olympic Engineering in completing the first phase of this constract. The National Aeronautic and Space Administration (NASA) provides technical management of the project for the Department of Energy.

The contents of the report are summarized as follows:

Section 2.0 <u>Summary</u> presents a summarized technical, historical, cost, and and public relations discussion of Project Sunburst.

Section 3.0 <u>Technical Description</u> describes the various components of the building space and domestic hot water heating and control systems for the demonstration solar building.

Section 4.0 Operation and Maintenance discusses the normal operation, routine

maintenance, minor repair maintenance, and major repair maintenance provisions for the solar demonstration system.

Section 5.0 <u>Acceptance Tests- Description and Results</u> outlines the acceptance test plan and summarizes the results. The actual acceptance tests are incorporated as Appendix B.

Section 6.0 <u>Operational Performance and Problems</u> provides a summary of the system's operating and maintenance history during the preliminary period of operation while the system was being insulated and otherwise completed.

The Specifications for Mechanical Work contain detailed information on components and installation techniques used, and have been included as Appendix A; start-up procedures and functional acceptance tests comprise Appendix B; Project Sunburst drawings have been included as Appendix C; and selected exhibits from the Project Sunburst public relations program have been included as Appendix D.

#### 2.0 SUMMARY

#### 2.1 TECHNICAL SUMMARY

Project Sunburst, a 14,400 square foot office building located in Richland, Washington demonstrates solar space heating and cooling and solar domestic hot water heating in the Pacific Northwest desert.

The demonstration system is designed to provide 71 percent of the space heating, 97 percent of the space cooling, and most of the domestic water heating required for year around operation of the building. An array of 6,000 square feet of roof-mounted ethylene-glycol/water cooled General Electric flat plate collectors supply energy through a heat exchanger to an underground insulated 9,000 gallon thermal energy storage tank (TES). In the heating mode hot water is pumped directly from the TES tank to 8 water-to-air coils in the forced air ductwork on demand by 8 zone thermostats. In the cooling mode a 25-ton solar hot water-driven Arkla absorption chiller cools water in a 2,000 gallon storage tank to supply cold water to the same water-to-air coils. A double-pass heat exchanger permits heating domestic water from the solar system hot water storage tank.

The demonstration involves two identical single-story office buildings within a four-building office complex known as Hanford Square. The buildings are in close proximity to one another and both are oriented with long dimensions eastwest. The buildings have the same external climatographic exposure and nearly identical internal environmental conditions. The occupancy of the control building is about 100 persons and of the solar building approximately 50 persons. Building One, the control building, is heated and cooled by a conventional electrically-powered heat pump system. Building Two, the solar building, is equipped with solar powered space heating and cooling and hot water heating systems, which are backed up by conventional electrically-powered heat pumps and electric hot water tank. The solar building has a central controller so that heat pumps operate only if solar input is inadequate to handle the heating or cooling loads. Meter readings of electrical energy consumption in kwh are recorded monthly in each building. Comparing the energy consumption of Project Sunburst to the identical non-solar building on the same site shows that 46,000 kwh were saved in the first 6 months

of solar operation from March to August 1978. Solar insolation measurements are recorded as part of the government supplied data acquisition system installed on the site, as well as the solar system performance characteristics (i.e., fluid temperatures and flows and operational modes). The efficiency of solar heating will be correlated with insolation to obtain diurnal and seasonal characteristics and reported as part of the analysis of solar data taken by the data acquisition system and processed by IBM at NASA's Marchall Space Flight Center for the Department of Energy.

Final acceptance testing of the solar system was completed in April 1978, and the 50 point D.O.E. data acquisition system was installed in August and operational in September 1978.

#### 2.2 HISTORICAL SUMMARY

Olympic Engineering, in response to ERDA's Solar Energy Proposal PON DSE-75-2, submitted a proposal on November 24, 1975 to provide solar hot water heating, space heating and space cooling for the Hanford Square project at Richland, Washington.

The solar project designated Project Sunburst was awarded by ERDA on April 7, 1976 with construction commencing on May 1976. The cornerstone for the building was set on June 4, 1976.

The solar contract for Project Sunburst was signed on June 30, 1976 for a total contract price of \$667,000.

The construction of the solar building and the solar system was impacted by a regional plumbers strike from June 2, 1976 thru January 27, 1977. The original schedule called for construction to be completed the last week in November 1976 with start-up complete the first week of December 1976 (as shown on Figure 1). The actual schedule of construction for the solar system piping, which started the last week in January 1977, is shown in Figure 2.

The solar non-plumbing work such as the solar equipment basement, solar storage tank installations and cooling ponds were continued during the strike period. Due to the extra work to perform this work-around effort and the escalation of cost due to the strike and the extraordinary length of the strike period, the program experienced a cost over-run which was evident in mid-June 1977. When the cost over-run occurred, Olympic Engineering was advised to stop work by the D.O.E.

# SUNBURST MASTER SCHEDULE (ORIGINAL)

			•	19	76		<u>:</u>	
	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
DESIGN								
G.E.								
							: :	
O.E.C.								
PROCUREMENT								
CONSTRUCTION								
CONST. MGT.								3
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START-UP								

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# SUNBURST MASTER SCHEDULE

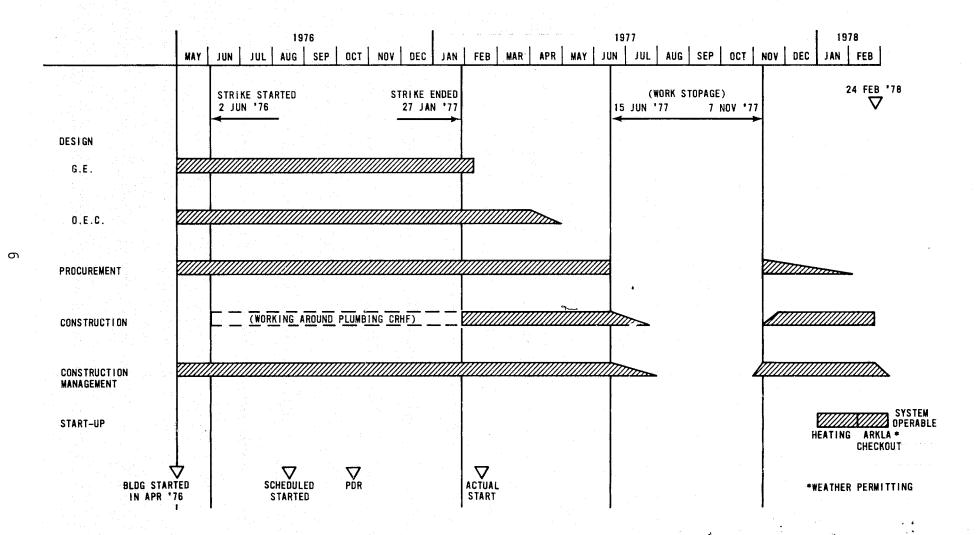


FIGURE 2

until the cost over-run problem could be resolved. Renegotiation of the contract was achieved on November 14, 1977 for the new total price of \$747,226.

Work on the plumbing and electrical system was resumed immediately. The heating portion of the system was complete on December 22, 1977. Due to a persistent cloud cover the first solar heating operation and check-out did not take place until February 10, 1978.

The Chilled Water System was completed on March 1, 1978. However, due to another persistent cloud cover, the start-up of the Absorption Chiller and check-out of the Cooling System was not completed until April 26, 1978.

The Data Acquisition System contract was awarded on June 6, 1978 for the sum of \$13,500. Work started immediately with installation of the temperature transducers and flowmeters.

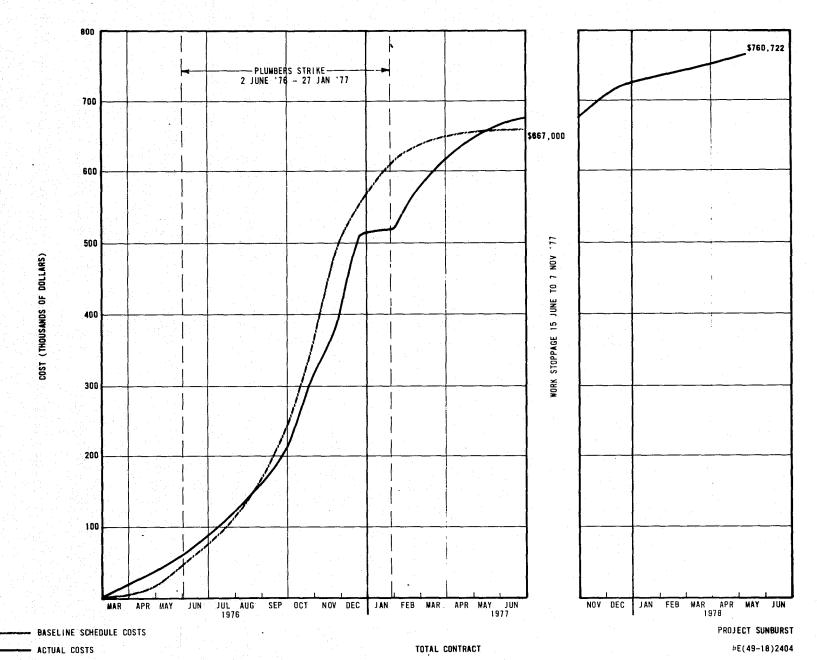
Electrical connection of the instrumentation to the Data Acquisition signal conditioner and transmitter was started July 5, 1978 and completed July 26, 1978. Final installation of the Site Data Acquisition Subsystem, with checkout and start-up, was completed on August 11, 1978.

#### 2.3 COST SUMMARY

A breakdown of the original cost estimate of \$667,000 and the actual cost of \$760,722 at the time of project completion is presented in the following table:

	Original Cost Estimate	Actual Cost <u>Estimate</u>
Construction Cost Preliminary Design, Travel, Public Relations	\$173,051 , 39,124	\$262,179 41,642
Procurement Cost & Displays	\$191,761	\$151,050
Design Cost	\$163,251	\$174,446
Management Cost	\$ 99,813	\$131,405
TOTAL COST	\$667,000	\$760,722

Figures 3 through 7 show the estimated and actual cost schedule curves for total cost, procurement cost, design cost, and management cost. Actual cost includes all monies billed and paid. Construction cost includes mechanical and electrical. Design cost includes solar panel arrangement analysis, panel array calculations,



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FIGURE 3

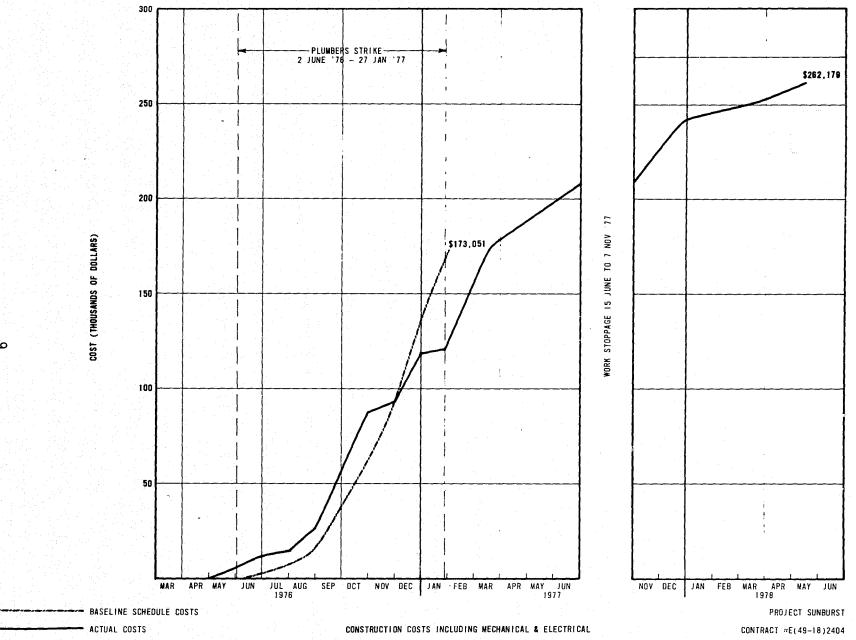
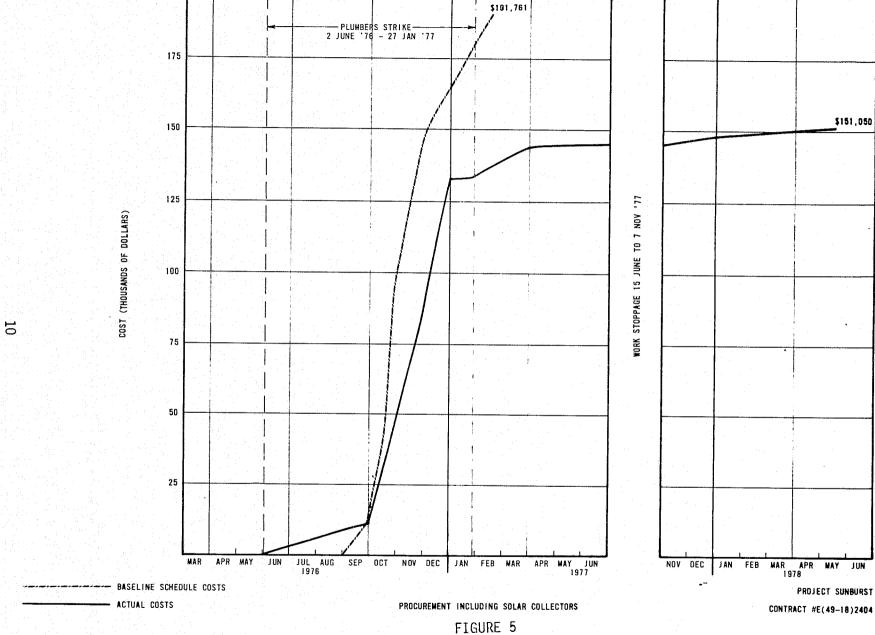
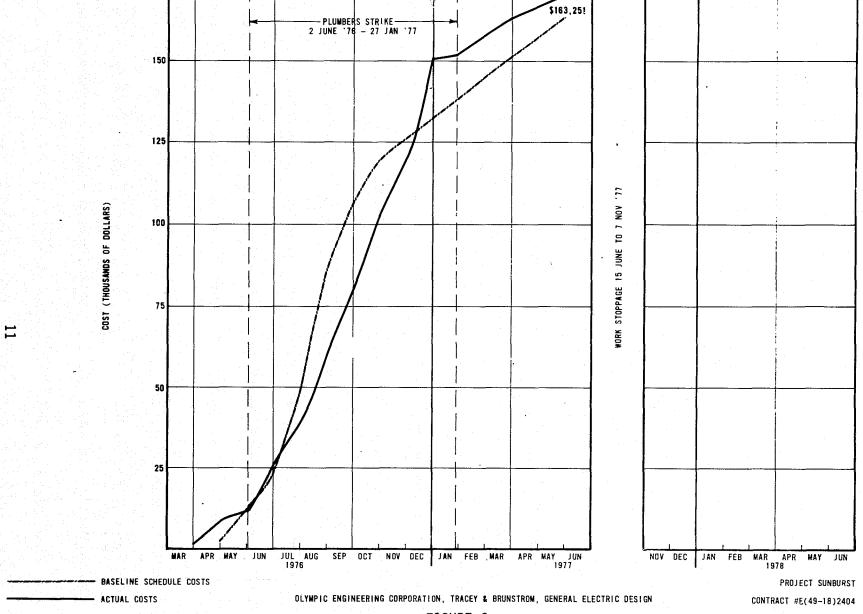


FIGURE 4



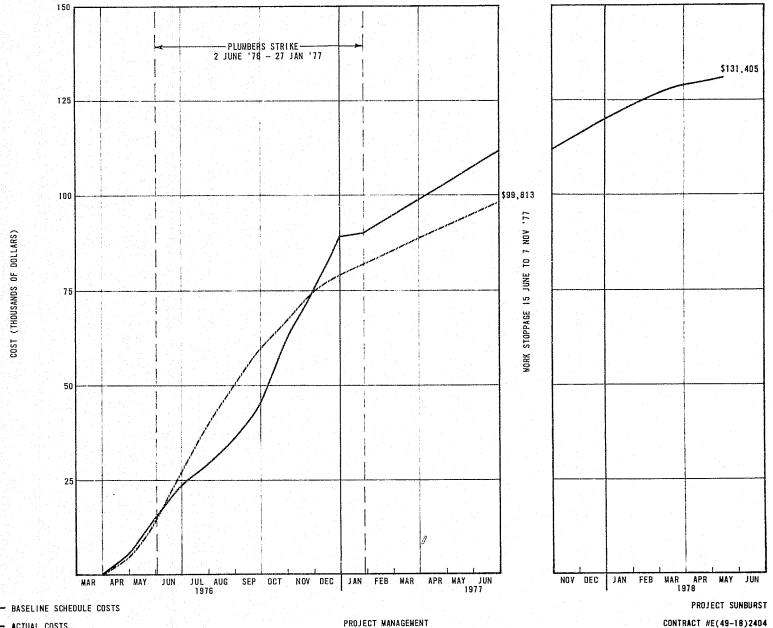


\$174,446

175

FIGURE 6





ACTUAL COSTS

FIGURE 7

building panel mounting, panel piping and manifolding, piping systems design, and other related solar design. Management cost for Project Sunburst includes program and construction management.

Figure 8 shows the cost schedule for preliminary design cost, travel, public relations and displays for the solar system. At the time of system completion these costs totaled \$41,642.

In accordance with contractural requirements, the following is the status on subcontract procurement on ERDA Contract EX-76-C-01-2404.

Subcontracts for subject contract were awarded as follows:

1.	Small Business Enterprises	\$288,672
2.	Minority Business Enterprises	0
3.	Labor Surplus Area Awards	N/A
4.	Other than 1. or 2.	\$218,202

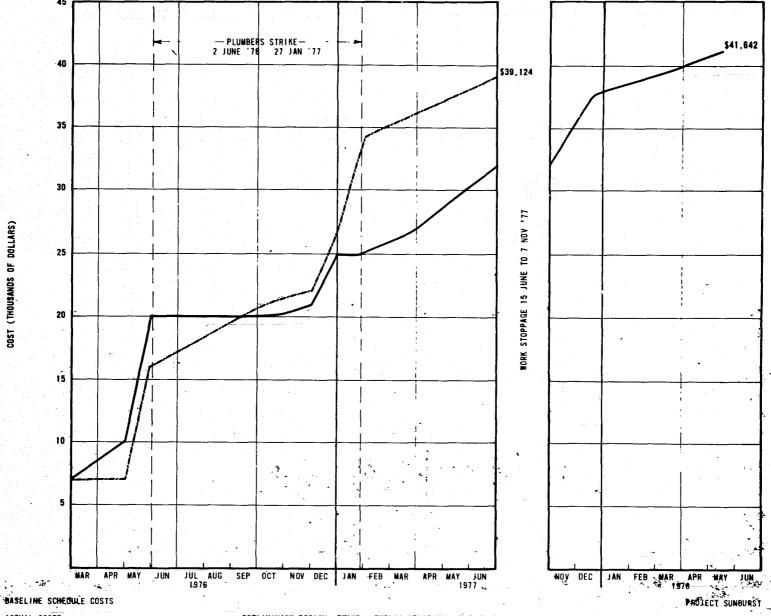
#### 2.4 PUBLIC RELATIONS SUMMARY

The Olympic Engineering Corporation has provided a program of fostoring public awareness of Project Sunburst, and of exhibiting the system and its operation to individuals and groups responding to this publicity.

The public has been kept aware of Project Sunburst by public speaking engagements and Olympic's solicitation of press coverage of various milestones in the project from its inception to the present. This coverage has appeared on radio, television and in newspaper articles, and included (1) Award of the project grant on April 1976, (2) Cornerstone laying ceremony in June 1976, (3) Occupancy of the solar building in February 1977, (4) Final construction phase of the system in April 1977, (5) First two days of successful operation in February 1978, (6) Project Sunburst dedication ceremonies in April 1978, and (7) Report of energy saved by the system in October 1978. Press releases of these events were published in the Tricity Herald, a regional daily paper with a circulation of 39,600. Each of these articles dealt exclusively with Project Sunburst and all but one included pictures. The first event, award of the project grant, also appeared in The Christian Science Monitor, The Wall Street Journal, three Seattle daily papers and a Spokane daily paper.

A description of Project Sunburst was included in the May 1978 issue of Solar Engineering Magazine. Two other nation magazines included references to the





ACTUAL COSTS

PRELIMINARY DESIGN, TRAVEL, PUBLIC RELATIONS, & DISPLAYS

FIGURE 8

CONTRACT #E(49-18)2404

project (articles were submitted to other magazines as well).

Public speaking engagements included at least 55 public speeches in addition to tour-talks to visiting groups. The speaking engagements range from large conference groups (such as the 800 architects and engineers in attendence at a 1977 seminar in Seattle) to administrative staff meetings of utility officials, DOE personnel and interested private industries. A paper was presented at the D.O.E. Solar Workshop in New Orleans in 1977 and another paper was published in the proceedings of the 1978 solar conference in San Diego.

Visitors and tour groups included a wide spectrum of interests, including students of all levels, farmers, businessmen, senior citizens groups, teachers, government officials (including Washington's governor) and scientists and other professional people. The 575 entries in the guest registration book represent only a small fraction of those who have toured Project Sunburst.

Special provisions have been made for showing visitors the operation of the solar system. A lobby display shows the supply and return lines of the roof-mounted collectors, the supply and return lines of the solar-heated water being delivered to the building, the supply and return lines of the Arkla-chilled water being delivered to the building, and the solar-heated domestic water being delivered to the building domestic hot water system. These seven lines are all fitted with thermometers and displayed behind a glass case so the temperatures can be readily noted.

The lobby display also has a large schematic drawing showing how the system operates. Visitors are given an explanation of the systems operation by the host (the project manager or other qualified representative) in reference to the schematic representation and temperature display. They are then taken to the roof, where a large visitor's platform has been constructed, and then to the equipment basement. Visitors are also given hand-outs explaining the system's operation and its role in the D.O.E. demonstration program.

### 3.0 TECHNICAL DESCRIPTION

The Solar Demonstration Building HVAC installation is an integrated arrangement of solar and conventional subsystems, each with its own fully automatic control system. This permits independent or simultaneous systems operation. The control logic design utilizes solar inputs as the prime energy source with the conventional system used in a back-up role.

The conventional ducted forced-air system consists of eight roof-mounted heat pumps to provide space heating and cooling. The solar system uses roof-mounted flat plate solar collectors to heat an ethylene glycol and water fluid, which passes through a liquid/liquid heat exchanger and transfers its thermal energy to heat water, which is stored in the Thermal Energy Storage (TES) tank. This stored energy is then used directly for heating or converted through an absorption chiller to provide space cooling. HVAC solar energy is transferred through a coil mounted in each heat pump air handler which is supplied with either hot or cold solar conditioned water. Provision has been made for domestic hot water heating from the TES tank through a double-pass heat exchanger.

#### 3.1 SOLAR SYSTEM DESCRIPTION

The Solar System is shown in Figure 9. The system consists of the following major elements:

- 'A pressurized closed-loop roof-mounted flat plate collector array containing 33% ethylene glycol for freeze and corrosion protection. It connects to a shell-and-tube heat exchanger to isolate the ethylene glycol solution loop from the water in the storage and utilization circuits.
- 'Pumps, heat exchangers, control valves, expansion tanks, and other fluid-handling equipment located in a mechanical room beneath the south entrance lobby.
- 'Hot water and chilled water storage tanks buried beneath the south entrance walkway.
- Interconnecting piping.

요꼽

'An automatic solar control system which provides for using energy directly from the main heat exchanger and storing the excess. The controls are interfaced with the conventional heat pump installation and are designed to utilize solar inputs as the prime energy source.

# 3.1.1 Solar Collector Loop

The Solar collector Loop consists of 252 General Electric FP-2 double-glazed flat plate collectors arranged in 13 rows on each half of the building, interrupted by the centrally located heat pump array, visitors stairway and viewing area.

The reverse return manifold system design provides an east and a west bank of collectors, with rows varying in length from 8 to 12 collectors. Each of the 26 rows contains a circuit setter valve to facilitate the rapid measurement and balancing of row flow rates so that each collector receives 1/2 gallon per minute.

The collectors have an integral distribution manifold at the lower edge of the absorber plate with an inlet nipple at one end and an outlet nipple at the other. There is an integral collection manifold at the upper edge with an inlet nipple at one end and outlet nipple at the other. Both manifolds are part of the absorber and serve to collect energy. The manifolds are hydraulically connected within the collector plate by two serpentine energy collecting passages. With the upper corner at the inlet end and the lower corner at the outlet end of each row plugged, and with the rows then connected to the appropriate pipes in a parallel flow distribution system, all elements, including the absorber serpentines, are hydraulically connected in parallel. Up to 12 collectors can be interconnected at their corners with high temperature E.P.D.M. hoses to provide a self-headered arrangement with 1/2 GPM flow distribution to each collector. The maximum 12-row length is determined by the fact that the center collectors will have a reduction of flow of approximately 20%, a corresponding 20% temperature increase in the absorber and an associated average decrease in collector efficiency of approximately 1%. This is acceptable. With manifold pressure drops limited to 15% of the

<sup>\*</sup>Ethylene Dyene Propylene Monomer

collector pressure drop, this arrangement results in an acceptably low collector array pressure drop commensurate with maintaining uniform flow distribution.

The EPDM rubber hoses used for collector interconnections serve several purposes. They provide coolant flow to and from the collector plates. They provide an essentially stress-free accommodation for absorber thermal expansions and/or misalignment. Since the collectors have electrically isolated absorber plates to prevent direct galvanic couplings within their own housings, the electrical insulation properties of the hoses are utilized to provide a convenient dielectric-type connection to systems external to the housing.

Although normal operating fluid velocities will keep the collectors and interconnecting tubing clear of entrained air, accelerated flows are set up using circuit setters to flow entrained air out of each row at the time of initial filling. Vent valves have been provided at the inlet end of most rows to facilitate initial fill and draining.

The collector loop would provide a 16<sup>o</sup>F temperature rise under the conditions listed below, where the collectors are operating at 50% efficiency:

## Assumptions:

```
252 flat plate FP-2
Number of Collectors and type
Effective Area Per Panel
                                                             23.1 square feet
Absorption/Emissivity
                                                             .94/.34 selective coating
                                                             250<sup>0</sup>F
Maximum Collector Temperature
                                                             110<sup>0</sup>F
Maximum Ambient Temperature
Collector Flow Rate
                                                             0.5 gpm/collector
                                                             35% Prestone II/Water (by volume)
Collector Loop Fluid
Collector Efficiency
                                                             50%
Specific Gravity (33% Ethylene
                                                             0.98 @ 250<sup>0</sup>F
    Glycol)
Specific Heat (33% Ethylene
                                                             0.94 Btu/#<sup>O</sup>F @ 250<sup>O</sup>F
    Glycol)
                                                             320 Btu/ft<sup>2</sup> hr
Maximum Solar Insolation
where \Delta t = \frac{Q}{WC_p} = (.50) \frac{(252 \times 23.1 \text{ ft}^2)(320 \text{ Btu/ft}^2 \text{ hr})}{(252)(0.5 \times 8.34 \times 60 \times 0.98 \text{#/hr})(0.94 \text{ Btu/#}^0\text{F})}
```

The collector loop includes a shell-and-tube heat exchanger which utilizes pumped cooling pond water for system over-temperature control. Temperature extremes can occur when the solar insolation-to-building load ratios are high for extended periods or in the event of a power failure or system malfunction. Shell-and-tube heat exchangers of the small tube type were selected because of their availability, economy, efficiency, and low thermal mass. They are located in the mechanical room for ease of maintenance and for common access to connections for remotely located tanks.

# 3.1.2 Energy Storage and Utilization Loop

The Solar Energy Storage and Utilization Loop, as shown in Figure 9, includes the thermal energy storage tanks and modulating bypass valve, solar domestic hot water heater circuit, an economizer (not hooked up) to preheat the solar domestic hot water, the main heat exchanger with bypass valve, and the primary pump loop that supplies hot water for heating and cooling. Solar cooling is accomplished with an Arkla absorption water chiller coupled to a chilled water storage tank. This storage tank acts as a thermal capacitor and thereby reduces cycling of the chiller during low load periods.

The solar/conventional HVAC system interface occurs in each of the eight zone heat pump air handler assemblies. A combination solar heating/cooling auxiliary water coil, located in each heat pump air handler, is connected and valved to both the hot and chilled water manifolds. This selectively permits either heating or cooling in each of the eight zones.

#### 3.2 CONTROL SYSTEM

#### 3.2.1 General Description

The HVAC system for the Hanford Square office building consists of a conventional eight-unit heat pump installation interfaced with a separately controlled solar heating and cooling subsystem with water coils in the heat pump air ducts. The solar system interface includes an Arkla water chiller. Operation and interfacing are defined in the following paragraphs. The system has been designed for fully automatic operation and will utilize solar inputs as the prime energy source for space conditioning with the heat pump array for backup.

<sup>\*</sup>A drain-down of the collectors would be necessary for anything more than a brief power failure.

### 3.2.2 Control Box

The control box, designed by General Electric, is made from a standard NEMA-12 enclosure and houses all of the soiar system control logic components. The internal components, which consist primarily of relays, differential thermostats, timers, and interconnecting wiring, are off-the-shelf items.

# 3.2.3 Sequence of Operations

In the Solar Collector Loop, the collector loop pump P1 is energized whenever the absorber plate-mounted thermal switches TS1 or TS2 close, at  $180^{\circ}$ F for cooling or  $120^{\circ}$ F for heating loads respectively. The set points are changed automatically through system demand switches - SDI for cooling and SD2 for heating.

The basic components of the system are shown in Figure 9.

In the Energy Storage and Utilization Loop, the hydraulic circuit has been designed to function under either of two basic operating modes. The first mode uses energy directly from the main heat exchanger and stores any excess. In the second mode, stored energy from the TES tank is used. In order to facilitate the description of the system component interactions we will assume a certain system relationship as a starting point and follow the system functions as they would normally develop.

When there is no heating or cooling system demand and solar inputs are not available, the following component status exists:

- 'V1 is closed
- 'V2 is positioned for "A" flow
- $^{\circ}$ V3 is modulated by C3B to use stored heat to maintain the primary loop hot water supply temperature at  $140^{\circ}$ F
- 'V4 flow bypasses the Arkla generator
- 'P1, P2 and P3 are off

When heating demand occurs (through switch SD2, not shown) component status changes to the following:

P3, the heating system hot water circulating pump, starts
V5 will modulate to temper the primary hot water supply with return
water to satisfy controller C5B which is reset by outside air sensor C5A

When a cooling demand occurs (through Switch SD1, not shown) the following sequence is generated:

- 'Chilled water pump P4 will activate
- \*Controller C3A will modulate V3 to satisfy a new 210<sup>O</sup>F set point from the TES tank

Before the Arkla can become functional, the following condition must be satisfied:

The Hot Water System (HWS) minimum startup temperature at the TES tank at thermal switch TS10  $> 180^{\rm O}{\rm F}$  or the primary supply loop at thermal switch TS7  $> 180^{\rm O}{\rm F}$ 

If either condition is satisfied, then a demand through either chilled water storage tank thermal switch TS4 or TS5 will:

- 'Activate the Arkla control system
- 'Activate the Primary HWS pump, P2

The Arkla absorption chiller has a self-contained, independent control system that requires only manual, seasonal turn-on and established flow in the chilled water circuit. It controls the modulating valve V4 to match generator temperatures to chilled water load demand and will signal the condenser water pump, P5, to function when required.

Cooling demand also exists simultaneously with, but independent of, SD1 when the chilled water storage tank temperature at thermal switch TS4 >  $50^{\circ}$ F. The Arkla will continue to operate after space requirements are met until the chilled water storage tank temperature at thermal switch TS4 is at least  $44^{\circ}$ F.

An extraordinary demand for Arkla operation exists whenever the solar system over-temperature control condition is approached in the TES tank, (greater than  $220^{\circ}F$  as sensed by thermal switch TS9). When this occurs, a new chilled water tank low temperature cut-off limit of  $38^{\circ}F$  is established for the control circuit using thermal switch TS5. This permits conservation of potentially wasted energy.

A thermal switch and timer circuit will shut down the Arkla if the HWS temperature at thermal switch TS8 drops below the  $170^{\circ}$ F set point during a continuous five minute period. The cycle will not start again until the minimum  $180^{\circ}$  startup

temperature at thermal switch TS7 or TS10 is obtained. The time delay prevents cycling due to system temperature transients or occasional passing clouds.

A controller, C7, modulates V8 to mix cooling pond and hot condenser water to limit condenser inlet temperatures above a minimum of 75°F to prevent freezing inside the chiller.

Through the following control system logic, all of the preceding functions can occur during periods when solar energy is being supplied directly from the main heat exchanger. In order to have available solar energy, the collector loop pump P1 will have been started by thermal switch TS1 or TS2. Pump P2 operates simultaneously with P1. As the collector loop temperature rises, a comparator circuit C1A/C1B determines the position of V2 as follows: When C1A > C1B +  $20^{\circ}$ F valve V2 shifts to the full "B" position to use solar heat directly from the main heat exchanger. This operation continues until the temperature ratios decrease to C1A > C1B +  $3^{\circ}$ F. At this point, valve V2 shifts to the "A" flow position and again bypasses the main heat exchanger. In addition to its functional control of V2, the C1A/C1B comparator simultaneously drives and locks V3 into the full "A" flow position while criss-crossing the connections from the C3A/C3B controllers, thus preparing valve V3 for "reverse" modulation.

During this operating mode all collected solar energy is used to maintain or boost the primary storage loop temperature. A second comparator circuit, C2A/C2B, unlocks valve V3 to permit the aforementioned "reverse" modulation when the loop temperature exceeds the TES tank temperature by  $12^{\circ}F$ . Storage of excess energy occurs during the "reverse" modulation and continues until the differential decreases to  $3^{\circ}F$ . At this point V3 returns to full "A" flow.

For limiting overall system temperatures, a thermal switch in the TES tank, TS3, will energize the cooling pond water pump P7 whenever system temperatures exceed 230°F. Heat exchanger HX-1 in the collector loop has been sized to handle maximum insolation loads and therefore no energy will be added to the storage loop. P7 will continue to operate until the TES tank temperature decreases 1.5°F.

In review, the system will accomplish the following functions automatically: Energize collector loop when absorber temperature rises to  $120^{0}$  or  $180^{0}$  for heating or cooling operation, respectively.

- 'Maintain the primary utilization loop at  $140^{\circ}$ F or  $210^{\circ}$ F for heating or cooling operation, respectively.
- 'Supply primary loop energy from the TES tank through V3 modulation.
- Supply primary loop energy from the main heat exchanger and store excess heat through V3 reverse modulation when the temperature differentials are appropriate.
- Limit TES tank temperature to 230°F.

In the Solar Domestic Hot Water (SDHW) System a comparator circuit, C6A/C6B, permits P6 to run whenever the TES tank temperature exceeds the SDHW tank temperature by  $12^{0}$ F. The pump can run until the differential falls to  $3^{0}$ F or until the thermal switch TS6 limits the tank temperature to  $160^{0}$ F.

## 4.0 OPERATION AND MAINTENANCE

#### 4.1 INITIAL OPERATION

Initial operation of the Project Sunburst solar system requires making certain preliminary checks to verify the system contains no major functional anomolies, performing leak tests, flushing out the lines, filling the fluids and purging entrapped air, balancing collector flow rates, and making certain control system initial adjustments. These start-up operations are summarized in Section 4.1 and given in detail in Appendix B of this report.

#### 4.2 ONGOING OPERATION

Subsequent operation of the system is totally automated, so once the system has been checked out, filled, and started up, then only occasional routine maintenance is necessary; changing/purging filters, lubricating pumps and motors, and maintaining the ponds.

The solar system is designed to automatically control normal winter and summer operation and over-temperature and over-pressure conditions. The ponds and the heat pumps, however, require special attention at the advent of the freezing season. The ponds are drained to prevent damage from freezing. The heat pumps have motor-operated economizer vent louvers for cooling which permits outside air to enter the system during periods of cooling whenever the outside air temperature is below 65°F and above 35°F. These economizers must be mechanically and electrically disconnected and locked/closed during the freezing period of November 1 thru March 15, since a failure mode can permit the outside air to enter the heat pump and freeze the solar coils if the outside temperature is below freezing.

#### 4.3 ROUTINE MAINTENANCE

# 4.3.1 Heat Pumps

The eight heat pumps require replacement of their filters every four months. These filters are accessible through the side panels of the air handlers. In addition, the heat pumps must be winterized as noted in 4.2 above.

#### 4.3.2 Arkla Condenser Water System

The Arkla condenser water filters require cleaning every 60 to 90 days during normal Arkla operation. During periods where high winds cause dirt and debris to enter the ponds a more frequent cleaning period is required. There are 3 Cuno commercial-duty water filters in the pond system. Each filter unit requires 12 cartridges of 50 micron filtration.

## 4.3.3 Cooling Pond Circulation Pump and Filters

There are two swimming pool type sand filters in the pond system to maintain a circulation and filtration to the pond water during periods when the Arkla system is not in operation. These sand filters require periodic inspection and cleaning by back-washing.

## 4.3.4 Cooling Ponds

The cooling ponds require regular cleaning to prevent debris from building up in the ponds, causing an overload on the normal algacide concentration and inundating the water filter system. Inspection and cleaning of filter system inlet screens is required on a regular basis. Algae growth is controlled by adding 32 ounces of agaetrine every 2 weeks for each pond (the cooling ponds have required an inordinate amount of maintenance in this locale because of blowing sand and debris, especially tumbleweeds).

#### 4.3.5 Solar Pumps

The electric motors and pumps used to operate the solar system (P1, P2, P3, P4, P5, P6, and P7) require lubrication once every year. A 20 weight motor oil is used to fill the reservoir of the motor and pump. This will normally be performed in the spring of the year.

#### 4.4 MINOR REPAIR MAINTENANCE

#### 4.4.1 Shut-Off Valves

In order to facilitate minor repair/replacement of components the system contains 57 manually operated valves that can be closed to isolate the part of the system that needs repair/replacement so a system drain-down is not required.

Valves are installed at the inlets and outlets of the six pumps, three heat exchangers, three filters, three air separators and the Arkla chiller. These would all be left open except when isolating the component for service or replacement.

Some of these valves also permit closing off non-operating parts of the system. During freezing weather, when the ponds are drained, the valves to heat exchanger 1 and pump 7 (which allow dumping excess solar heat via the ponds) could be closed, and valves on the supply and return lines to the two ponds would also be closed in winter.

The two city water line valves for filling the ponds and the chilled water pressurization valve would be closed except during filling, and the inlet and outlet valves for the pond filter pumps would be closed except during pond cleaning. The system also provides an east pond inlet bypass/cut-off valve and outlet bypass valve, which are normally closed, and a bypass valve for heat exchangers 1 and 2. There is a cut-off valve to the roof, which is normally open, and a collector loop pressurization valve, which is closed except during emergencies. Two solar panel vent valves are provided to vent the collectors during extended shutdown.

These valve positions are given in tabular form in Appendix B. The functions of the system's remotely controlled valves are discussed in Section 3.

# 4.4.2 <u>Component Servicing Or Replacement</u>

Procedures for adjusting, repairing or replacing each system component are detailed in the service catalog of the Project Sunburst system, which is comprised of the customer-supplied instruction sheets for each of the equipment items. This 216-page document is on file with the project manager and a duplicate copy is always kept on-site in the solar system mechanical room.

#### 4.5 MAJOR REPAIR MAINTENANCE

Whenever the system needs to be shut down and drained for major repairs it is necessary to follow the fluid-filling and start-up sequences discussed in Section 4.1 to make the system operational again. During emergency shut-downs, to insure a minimum in loss of the solar panel heat transfer fluid, provisions are made for draining the solar panel fluid into drums which provides sufficient

capacity to accept all the glycol/water fluid contained on the panels and roof piping. The fluid can then be returned to the system when the repairs are completed.

The solar panel fluid system is designed to permit the solar fluid to discharge automatically from the pressure relief valve when an over-temperature/over-pressure condition occurs.

## 5.0 ACCEPTANCE TEST-DESCRIPTION AND RESULTS

All of the components of the Project Sunburst solar system were purchased as off-the-shelf items, and are used in their normal mode and range of operation. It was therfore agreed upon by Olympic Engineering and the Department of Energy that a set of start-up procedures would be prepared that would encompass all of the operating modes, and these procedures would then also serve as functional acceptance tests for the system components. The heating portion of the system was completed December 22, 1977 and acceptance tested February 10, 1978. The cooling system was completed March 1, 1978 and acceptance tested April 26, 1978. These acceptance tests were performed by Olympic Engineering Corporation and are included in Appendix B. The Data Acquisition System was completed July 26, 1978 and acceptance tested by NASA personnel on August 11, 1978. The documentation of results for this system are not included in this document.

#### 5.1 LEAK TESTING

A check for gross leaks is made by pressurizing the system with clean shop air to 30 psi, then isolating and checking for pressure decay over a one-hour period. Once this has been achieved, leak testing with water commences.

# 5.1.1 Leak Checking of Water Loops

For water leak testing, each fluid loop to be tested is isolated and prepared for testing by capping or isolating any relief valves or vented tanks in the loop. Water is filled from a low point and air is vented from each high point until the loop appears to be air-free. The system is pressurized to at least 120% of the maximum pump discharge gage pressure and then surveyed for leaks.

Where leaks occur, the water leak testing is repeated after repairing the leak until no pressure decay is observed over a two hour period. Other loops are then added to this loop and the process repeated until all of the systems except the solar collector loop has been leak tested.

## 5.1.2 Leak Check of Expansion Tanks

Expansion tanks are filled at least half full and pressurized or vented as required to obtain the maximum operational static pump suction pressure.

## 5.1.3 Leak Check of Collector Loop

Fluid leak testing of the collector loop is done immediately prior to the final fill, so the collectors will not stand overnight without fluid after water flushing. The collector loop is filled until the air is purged from the high-point vents and then the collector loop pump is turned on, adjusted, and operated for at least 30 minutes to scavange any remaining air from the collectors (the collector loop can be filled only when the collectors are cool).

Should leaks occur, the process is repeated until the system can be pressurized to 120% of operational levels, isolated, and shut down for at least two hours with no observable pressure decay. This must be done when the collector temperature will not increase (e.g. sunset).

#### 5.2 CHECK FOR FOREIGN MATTER

After leak testing, the fluid is circulated for at least two hours at high flow rates in each loop to loosen any sediment. The system is then drained and the effluent examined for clarity. The filling, circulating and draining operation would be repeated until the outlet water matches the inlet water.

Strainers are then cleaned prior to the final filling operations.

#### 5.3 PREPARATIONS FOR OPERATIONAL TESTING

## 5.3.1 <u>Preliminary Preparations</u>

Before the final filling of the fluids, the entire system is checked against flow schematics to assure the components are correctly connected, that all non-essential wetted components (filter cartridges, flow meters, etc.) are in place, that vent valves are installed at all high points, and that all manual valves are in the correct operation positions (balancing valve settings are approximate). Three-phase pump motors are checked for proper direction of rotation and proper control of all pumps and control valves from the control box is checked.

All relief valves and overflows are checked to assure they are restored to their normal operating modes after the leak testing, and that provisions have been made for accommodating any overflow.

## 5.3.2 Final Filling

The ethylene glycol and water mixture is filled immediately after the leak testing and when the collectors are cool, as noted previously. Batches of 35% ethylene glycol solution are mixed in a tank and transferred to the collector loop by pump P8. Air purging is done as in the leak test filling, and the system is filled until the expansion tank is about 25% full. The system is then vented or pressurized with air until the net positive suction head required by the pump is attained. Set points are determined for balancing/throttling valves to achieve uniform flows through each collector, using the lowest settings consistent with design parameters and pump requirements. Valves and pumps are operated to deliver all collected energy to the TES tank.

To fill the hot water thermal energy storage loop, domestic water is connected to the system at a hose bib at heat exchanger 2. The TES tank is vented for filling by removing a temperature probe, and the heat pumps are vented for filling by depressing the shrader valves. Hose bibs on other lines in the loop can be opened to facilitate venting for filling.

## 5.3.3 Preliminary Control Settings

The control system requires preliminary adjusting of the reset ratio, initial temperature and throttling range on the valve #5 controller, and setting the temperature set points and proportioning ranges on the valve #3 high and low point controllers and the valve #6 controller. Settings are as per manufacturer's instructions. The valve #5 controller is reset to automatic, the system is energized, and subsequent operation is automatic.

#### 5.4 COMPONENT PERFORMANCE EVALUATION

## 5.4.1 Collector Loop Operation Check

Initial operation of the solar system was monitored under a variety of weather conditions. The temperature indicators in the collector loop in the lobby display (supply and return lines to the collectors) were checked against the design temperature parameters under various conditions to assure that the pump control and monitoring components were providing a fluid flow necessary and sufficient to maintain the design fluid temperatures. The initial flow-balancing adjustments, wherein a flowmeter was used to check each of the 26 collector rows, provided another verification of the predicted pumping requirements and system pressure drops. Operational

performance of the collector thermal switches TS1 and TS2, pump P1, Flowmeter FM1 and heat exchanger HX2 were thus checked, as well as the performance of the collectors.

## 5.4.2 Hot Water Loop Operation Check

During the initial period of operations the system stored energy in the TES tank, supplied energy to the building heat pumps and supplied energy to the Arkla chiller within the system design temperature ranges and design conditions. Thermometers (in the lobby display) on the supply and return lines for solar heated water being delivered to the heat pumps were monitored and compared with the thermometers on the collector loop. The temperatures of these lines indicated that solar energy was being delivered to the building heat pumps when no energy was being collected, indicating it had been stored and recalled from the TES tank as designed, and also directly to the system, as evidenced when the thermal storage was depleted but solar energy was being collected. This verified the operation of valves V1, V2, V3, and V5, pumps P2 and P3, flowmeters FM-2 and FM-3, thermal switches TS-3, TS-7, TS-8, TS-9, and TS-10, and comparators C2B, C3A, C3B, C5B and C6A. During periods of intensive ambient temperatures and solar insolation the system activated the overtemperature loop and pumped cooling-pond water via heat exchanger #1 as designed. This activated pump P7 through heat exchanger #1.

## 5.4.3 <u>Domestic Water Loop Operation Check</u>

A thermometer located on the domestic water line between the solar domestic hot water heater and the residential hot water tank inlet provided evidence that heat exchanger HX3, pumps P5 and P6, valve V-6 and comparator C6B were operational.

# 5.4.4 Arkla Chiller Loop Operation Check

Several months later the Arkla chiller was activated and functioned within the design parameters for the unit. Thermometers in the lobby display were mounted on the Arkla chilled water supply and return lines for the building heat pumps. The delivery of chilled water indicated that the Arkla absorption chiller was operating as designed, and the pump P4, flowmeters FM-3 and FM-4 and thermal switches TS-4 and TS-5 were operating.

#### 5.4.5 System Evaluation

Monitoring of the overall system operations as described in the preceding subsections provided information which would have identified any major system component that had failed, or that was not operating in the manner or range for which it was designed. However, a more precise evaluation of performance requires more elaborate means of data gathering and data reduction.

Instrumentation has been installed on the Project Sunburst solar system as part of a separate D.O.E. study to evaluate the solar system performance by monitoring and recording temperatures at 28 locations, fluid flows at 9 locations, power at 12 locations and solar insolation. Data is transmitted directly to a remote data-reduction computer.

### 6.0 OPERATIONAL PERFORMANCE AND PROBLEMS

The solar heating system has been operational fifteen months and the solar cooling system has been operational during one cooling season. In this section some of the problems that have arisen during this period are discussed.

The problems encountered have been typical of a system of this size and complexity, and system performance can be expected to increase markedly as these problems are resolved. In the October and November performance reports cited below the solar system contributed 25% and 41% respectively of the space heating and 19% and 23% respectively of the domestic hot water heating despite the mechnical and control difficulties discussed in Section 6.2.

#### 6.1 STATUS OF PROJECT

The solar building, occupied since January, 1977 was initially operated on its backup heating and cooling system powered by electrically driven heat pumps. The solar heating system was started up on February 10, 1978, once the major components and piping were in place. Some of the final completion tasks, notably the insulation of the piping, have been performed concurrently with this initial operiod of operation and are now complete.

The chiller provided cooling for the building during the summer of 1978. Detailed information on solar cooling system performance was not available during the 1978 season, however, since the 50-point data monitoring system became operational on August 11, 1978. The first monthly report was for the month of November. The data from this system is monitored in Huntsville, Alabama by the IBM Corporation under a separate DOE contract.

Reports based on the data acquisition system for November and December have been made available to Olympic Engineering. In addition to this, some indication of performance has been suggested by comparison of utility bills from the solar and control buildings, although lighting and other power consumption sources are also included in these bills, and building occupancy patterns have not been closely matched.

The collector array has been subjected to wind gusts between 60 and 70 mph without sustaining any damage.

#### 6.2 PROBLEMS, SOLUTIONS AND OBSERVATIONS

The flat plate collectors incorporate Lexan windows to eliminate glass breakage. Pumps are strategically located for rapid isolation, removal and replacement. The system can be manually operated by switch overrides. The water systems use sweat-fitted copper pipe to prevent leakage. No insulation problems are known at this time.

During the initial filling of the collector array the waterethylene glycol solution was mixed in batches in a 55-gallon drum and
pumped from the equipment basement upward into the collector array.

Start-up procedures called for completion of this operation and turning
on the circulating pumps before the collectors became hot. However,
because the rate of injection was limited by the rate at which the
batches were made up, the coolant overheated with accompanying generation
of low pressure steam which could not be released rapidly enough to
complete the filling operation. The filling was discontinued and pressure
was released by disconnecting appropriate hoses. A second filling was
started at 4 a.m. and was successfully completed without incident before
solar input became significant.

One source of unexpected expense was the fabrication of fiberglass piping for the solar collector-heat exchanger circuit. This material was specified to electrically isolate the entire array from the building interior and to help prevent galvanic action between aluminum collector passages and connecting pipe runs. Fabrication of circuitry from glass fiber epoxy piping involved more labor because of the craft's unfamiliarity with this type of plumbing technology.

The principle problems encountered in Project Sunburst construction occurred during installation because of a 30-week strike against all the area contractors by the Pipefitters' Local Union . The strike was not in any way solar related nor did solar work inhibit the final settlement.

This long period of inactivity and work-around, however, delayed completion and escalated costs of labor and material. Remobilization of plumbing contractor crews after the strike cost an additional 6 weeks for Sunburst. In addition, schedular incompatabilities created by this shutdown substantially reduced installation efficiency.

Other institutional problems which were resolved have included:

1) Potential jurisdictional dispute over placement of panels, which could have involved plumbers, sheetmetal workers and iron workers; plumbers were on the site and did the work, and 2) Interpretation of local building and zoning codes with respect to new solar additions. These were resolved in favor of making the installation as designed.

The following operation and maintenance problems have occurred during the period that the system has been in operation:

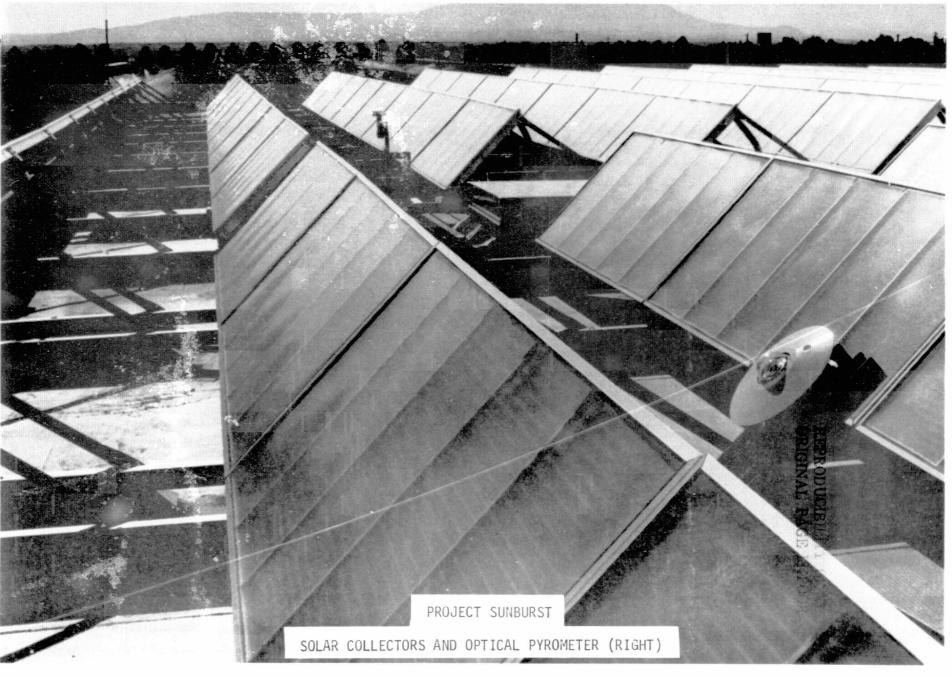
- The flate plate collectors have double glazing of Lexan. A
  few of the inner panels have warped enough to touch the hot
  absorber. No action is contemplated at present except to
  observe and report.
- The 252 flat plate solar panels' selective surface have shown a substantial but not consistant fading. This affects both the appearance of the panels and the system efficiency. Loss of efficiency of the solar panel coating will be evaluated from the Data Acquisition System readouts.
- The solar system with its glycol/water fluid has experienced emergency shutdown due to local power outages. During these occurrences the pressure relief valve relieved the system over pressure which caused a loss of the glycol/water. A recovery system has been installed consisting of four drums capable of storing the discharge from the pressure relief valve. The recovery system can also be used to mix glycol/water batches for introduction to the system. This reduces the introduction time and avoids the overheating problems encountered during the original system charging.

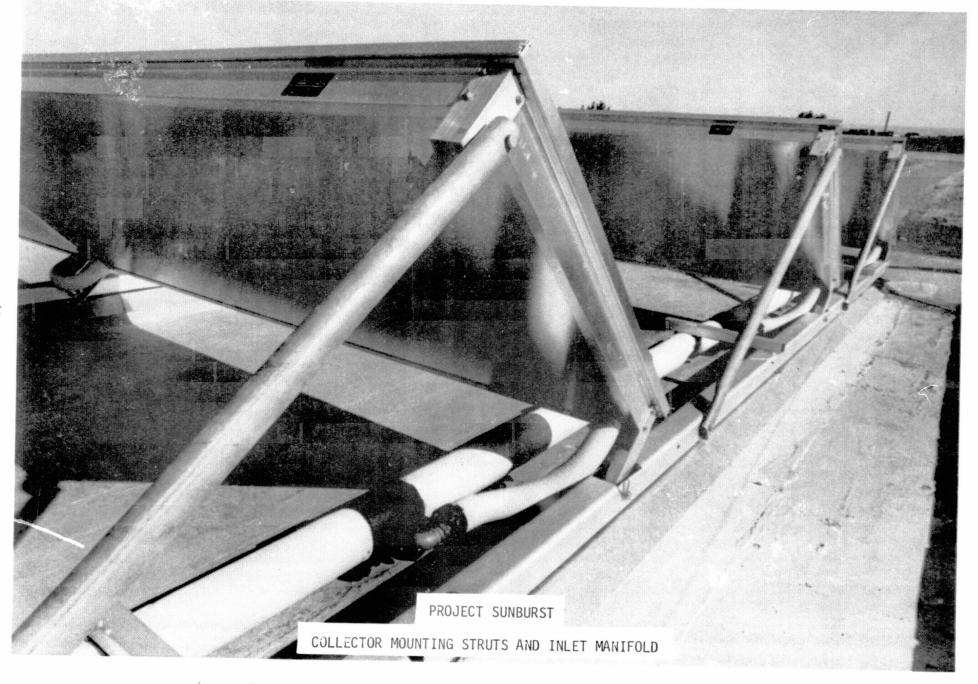
- The original installation contained heavy duty EPDM truck radiator hoses for expansion loops in the solar coolant feed piping on the roof. These hoses were found to deteriorate after several months exposure to the heat, glycol fluid and solar radiation. These EPDM expansion loops were replaced by conventional flexible metal bellows braided wire covered loops.
- Two leakages have since occurred in the solar panel connections. The first (October 1978) was a leak in a solar panel hose manifold. The leak was not noticed until midday and vapor locking in the panels made it necessary to vent and drain the system to roof level until early morning hours when the system could be refilled. The panel was replaced and the damaged panel soldered for use as a spare. The second leak (January 1979) resulted from separation of a hose connection to a panel during intensely cold weather. The fluid was not circulating and only a small amount was lost. The ethylene glycol content was increased from a 35% to a 50% solution.
- Pump P3, which circulates solar heated water to the building heating system, suffered a mechanical failure (October 1978) that required the repair of the pump and replacement of the motor. Pump P2 shorted out due to a bearing mounting failure causing the motor to torque against the flexible conduit (March 1979). This pump circulates solar heated water through the thermal storage tank, and when it failed an over temperature condition occurred in the collector loop, resulting in the collector fluid automatically discharging into the holding drums. Pump P5, which circulates pond water through the Arkla chiller, had to be cleaned of debris (May 1979) as discussed below.
- The flow of pond water through the Arkla chiller was insufficient to allow the Arkla to operate (April, May 1979). The piping for

circulating water between the ponds and the Arkla was cleaned out and the circulating pump P5 was dismantled and debris removed from the impeller chamber. The ponds have required a good deal of maintenance effort to remove leaves, tumbleweeds, litter, and small drowned animals, and the warm water temperatures accelerate algae growth. The ponds have proven to be the biggest maintenance problem.

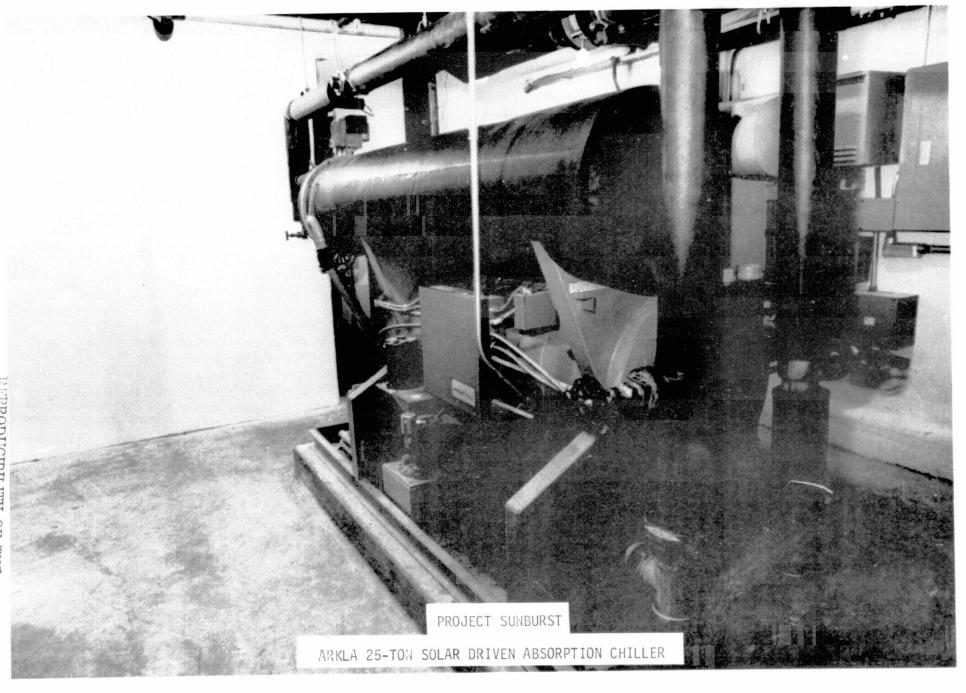
- The motor for the automatic control valve V2 shorted out, causing an over temperature in the collector loop (February 1979). The motor was removed and the system operated manually until the trouble was located and repaired. Temperature sensor C1B on the main heat exchanger loop locked in the open position and had to be replaced (January 1979). The leads to a temperature sensor in the thermal energy storage tank failed and were replaced because of water entering the manhole above the 9000 gallon tank (January 1979). Temperature comparators A1 and A2 failed and were removed and returned to the manufacturer for repair (February 1979).
- There have been several instances of thermistor and thermal switch failure. In November and December, thermistors in the TES tank failed which resulted in improper modulating valve response and a resultant loss of potential energy. In May, thermal switch TS10 failed which resulted in ARKLA malfunctioning. In these instances the instruments were usually in a severe hot humid atmosphere. The original light duty TS10 switch was replaced by a waterproof component.
- In general the control system for the Sunburst Project has not performed up to expectations. Since General Electric was not contracted to perform the final system check-out it has been difficult to define performance problem sources. General Electric and Rho Sigma have been cooperative in correcting the comparator and temperature sensor difficulties at their cost.

As Sunburst passes through the expected initial period of childhood illnesses, the system's performance can be expected to increase dramatically. Even with the mechanical and control difficulties experienced in November and December the National Solar Data Program monthly reports show that 25% and 41% of the building space heating and 19% and 23% of the building water heating requirements were being supplied by the sun's energy.

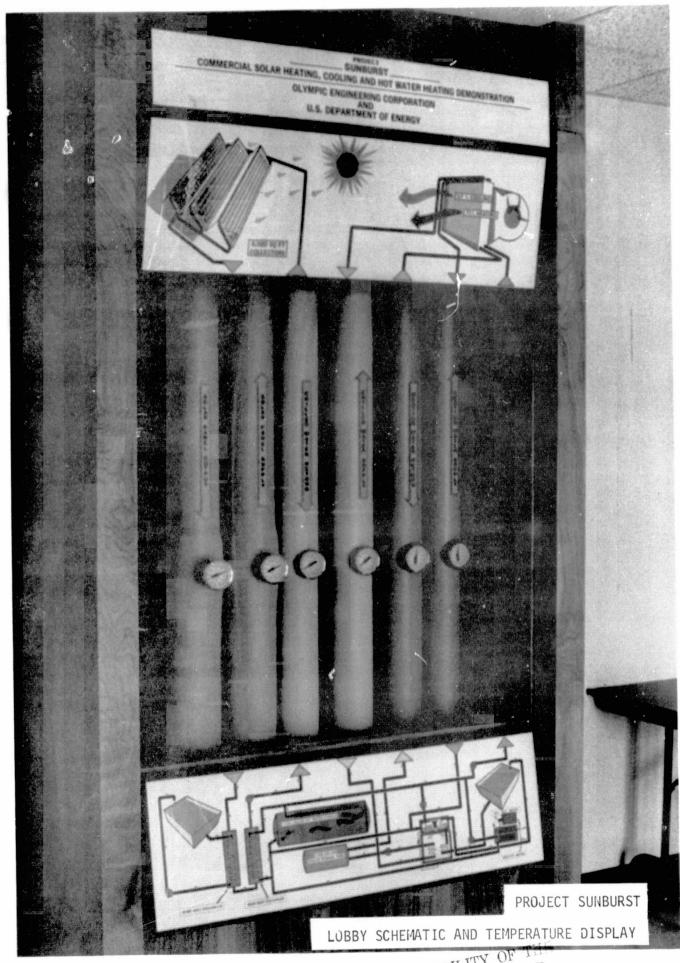




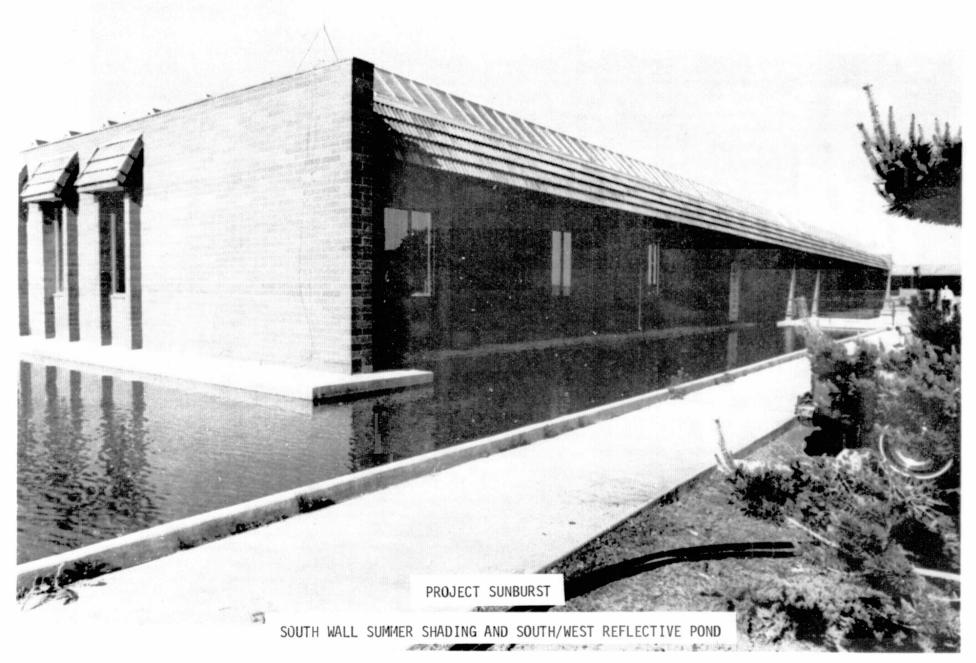
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# APPENDIX A

Project Sunburst
Specifications
For
Mechanical Work

# APPENDIX A SPECIFICATIONS FOR MECHANICAL WORK

#### INTRODUCTION

This document has been included as part of the Project Sunburst Final Report because it contains a detailed description of the system as it was actually built, including such information as:

- Designation of those phases of the installation that were handled by Olympic, by the general contractor (George A. Grant Co.) and by the mechanical contractor (Morrison Refrigeration and Heating, Inc.).
- 'Identification of items procured by Olympic and those procured by others.
- 'Manufacturers and model numbers of equipment items installed.
- Types of piping used, procedures for routing, mounting, and fitting the piping.
- Identification of types and location of insulation used.
- Operational description of instrumentation and system controls.

This section has been supplemented by a list of the manufacturer's Installation and Operating Instructions for each equipment item (the contents of the system service manual).

References to the pond spray system in this section are not applicable. The effectiveness of the ponds in operating the Arkla chiller condenser and dissipating reject heat was tested before the pond spray system was installed. It was determined that the ponds served adequately without the spray system, so the spray system was not installed.

## PROJECT SUNBURST-SOLAR DEMONSTRATION

**SPECIFICATIONS** 

for

MECHANICAL WORK

in connection with

SOLAR SYSTEM INSTALLATIONS

in

HANFORD SQUARE BUILDING No. 2
RICHLAND, WASHINGTON

OLYMPIC ENGINEERING CORPORATION 2952 George Washington Way Richland, Washington 99352

Set No. 4

12 October 1976

6039

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#### PROJECT SUNBURST

#### 15A.01 <u>DEFINITIONS - REFERENCES</u>

- A. The term "engineer" shall mean the person, or persons, authorized by Olympic Engineering Corporation to act in their behalf.
- B. The term "owner" shall mean the Olympic Engineering Corporation.
- C. The term "GC" shall mean the general contractor performing the general construction work.
- D. The term "MC" shall mean the mechanical contractor, or subcontractor employed to perform the work in connection with the solar system installation, or any of his subcontractors.
- E. The term "EC" shall mean the electrical contractor or subcontractor employed to perform the electrical work in connection with the solar installation.
- F. The term "provide" shall mean to furnish, install, and connect completely and ready for use the equipment or materials mentioned.
- G. The term "approved" shall mean approved by the engineer.

#### 15A.02 CONTRACTS

- A. The first phases of the solar system installation are being done by the MC as a subcontractor under the GC.
- B. The final phases of the solar system installation will be done after the GC has completed his general work in connection with the non-solar part of the building. If the GC's work is accepted, and the contract closed, then the MC will become a prime contractor for completion of the solar system installation.

#### 15A.03 SCOPE OF WORK

#### A. Prepurchased Items

Some items are being prepurchased by the owner, including GE flat solar collector plates, the Arkla water fired, water cooled chiller, the water storage tanks and other similar items. Such items will be delivered to the site by the owner. The contractor shall, except as otherwise noted on the drawings or in these specifications, provide the hoisting, including off-loading and storage if

## 15A.03 SCOPE OF WORK (Continued)

## A. Prepurchased Items (Continued)

necessary of owner-purchased items, and do all necessary field installations. The contractor shall be responsible for start ups, adjustments and normal guarantee work just as if the purchase of the equipment were a part of the contract.

## B. Cutting and Patching

- 1. Necessary cutting of concrete to enlarge existing openings and to make new openings shall be the responsibility of the MC. The filling of opening voids, waterproofing of patched areas, and the finished wall cover plates as hereinafter specified shall also be the responsibility of the MC. Sizes and locations of openings must be approved by the engineer.
- 2. The MC shall provide cutting for all necessary pipe openings in frame construction.
- 3. Cutting and patching of any roofing materials will be by the GC.

## C. Pipe and Equipment Supports

- 1. All pipe supports, hangers, etc. shall be the responsibility of the MC, except as otherwise noted.
- 2. Pipe support wells have been provided in the pond floors. The MC shall provide vertical supports for the pond sprinkler lines.
- 3. The concrete ceiling of the basement solar room has been poured and no inserts have been provided. The contractor shall provide all necessary supports for piping and equipment in this area. Submit and receive approval of loads and their locations, from engineer prior to starting work.

#### D. Sump

- 1. The pump drainage sump in the solar room has been installed by others.
- 2. The contractor shall provide the cover.

## E. Excavation

The excavation for water storage tanks outside the building will be by the GC.

## 15A.O3 SCOPE OF WORK (Continued)

#### F. Backfill

- 1. Backfilling to a minimum of 1 foot thickness around exterior of underground tanks and 1 foot over the top of tanks shall be with sand by the MC. Depending on the slope of excavation, the sand backfill will exceed 1 foot in certain cases.
- 2. Backfilling to within 6 inches over exterior piping shall be by the MC.
- 3. Backfilling other than called for above will be by the GC.

#### G. Tank Foundations

Concrete foundations with bolts for tanks will be provided by the GC. Raised concrete equipment bases in the solar basement will be by the GC.

#### H. Domestic Water System

- 1. The domestic water supply and the distribution system within the building to plumbing fixtures and water supply outlets will be by others. Certain tees, nipples and valves for branch line connections to solar systems are shown on the solar system drawings. These will be provided by the subcontractor installing the domestic water system.
- The MC shall connect to these valved outlets and shall provide all other piping and related work for the solar system installation.

#### I. Drainage Piping

- 1. There is a drain line stubbed thru the north wall of the solar basement, which connects to the sanitary sewer system.
- 2. The MC shall provide all solar pond circulating and drain lines, and the sump pump discharge line, which shall connect to the existing drain line at the north wall of the solar basement.

#### J. Solar Room Exhaust

The exhaust fan in the attic, including ducts, dampers, damper controls and roof hood which exhaust from the solar room shall be provided by the MC.

## 15A.03 SCOPE OF WORK (Continued) .

#### K. Electrical

- 1. The contractor shall provide the following electrical work:
  - a. All factory installed internal wiring and controls as a part of the Arkla absorption chiller unit, terminating in one junction box for connection by others.
  - h. Installation of electric motors supplied by the manufacturer as an integral unit with pumps, fans and other equipment, with marked motor terminals for connection by others.
  - c. Mechanically actuated process instruments and controls such as pressure switches, flow meters, liquid level controls, with electrical terminals for connection by others.
- 2. Electrical work by the EC, or equipment furnished by the Government will include:
  - a. Line voltage wiring for all motor driven equipment, relays, etc.
  - b. Connections to the Arkla absorption chiller.
  - c. All required electrical disconnects and starters.
  - d. All temperature and other sensors, including their installation, wiring, etc.
  - e. All data gathering equipment and its installation.
  - f. Electrical service to eight heat pump indoor fan motors, including starters and disconnects.

## L. Equipment

- 1. The following equipment and related work will not be a part of the solar work by the MC:
  - a. Eight heat pump packages, including economizer packages.
  - b. Humidification equipment.
  - c. Air supply distribution and return systems.
  - d. GE solar collector plates and their installation.

#### M. Piping

The MC shall provide all piping and related items, unless otherwise noted on the drawings or in the specifications, for solar panel connections and circulating systems, solar pond piping and sprays, piping for tanks, heat exchangers, circulators, pumps and solar heating and cooling coil installations.

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## 15A.03 SCOPE OF WORK (Continued)

#### N. <u>Insulation</u>

The MC shall provide insulation for the thermal energy storage tank, chilled water tank, interior tanks and heat exchangers, and piping as specified in Section 15H.

## O. Labels and Designations

The MC shall provide labels and designations for all equipment and systems and equipment provided by him under this contract, as more fully specified hereinafter, including piping, equipment, controls, etc.

#### P. Controls

- Controls in connection with the heat pump and air distribution system are not a part of this solar work.
- Instrumentation for temperature and flow will be furnished by others, but the MC shall provide tees, saddles or flanges as required and shall install the instruments.
- 3. The EC will provide all electrical work.
- 4. The MC shall provide all other controls necessary for the operation of the solar system equipment.

## Q. Painting

Painting is not a part of this contract unless specifically mentioned otherwise. See Section 15I.

### R. <u>Miscellaneous</u>

- 1. The MC shall provide screen enclosures around pond drains and an enclosure around liquid level sensors as detailed.
- 2. Provide manhole extensions and covers at grade above the thermal energy storage tank.

## 15A.04 PROVISIONS FOR EQUIPMENT INSTALLATIONS

All equipment in the solar room must be lowered thru the opening in the first floor where the removable stairs will be installed. In the future certain equipment may be removed and other equipment installed for further research. The layout shown on the drawings has been made with this in mind; however suggestions from the MC are welcomed.

#### 15A.O5 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. The drawings are partly diagrammatic and do not necessarily show the physical arrangements of the piping and equipment unless specifically dimensioned. Riser and other diagrams are schematic only and shall not be used for obtaining quantities or lineal runs of piping.
- B. Certain equipment and materials are specified by one brand name only to establish capacities and characteristics. The MC may propose substitute equipment as an alternate to that specified. For further description see the section on SUBMITTALS.

#### 15A.06 EQUIPMENT & MATERIALS

All equipment and materials provided shall be new, free from defects, and shall conform to the quality specified, unless specifically mentioned otherwise.

#### 15A.07 SUPERINTENDENCE & SUPERVISION

The MC shall maintain adequate supervision of the work and shall have a responsible person in charge at the site during any time that work under this contract is in progress, or when necessary for coordination with other work.

#### 15A.08 CODES

Work shall conform to all applicable codes and ordinances even though not specifically mentioned for each item. This includes the Uniform Solar Energy Code, 1976 Edition.

#### 15A.09 PERMITS

Check with owner to see if permits have been received and fees paid. If not take out and pay for all permits required, and pay all fees, inspection charges and other similar costs in connection with work under this contract.

#### 15A.10 PROTECTION OF EQUIPMENT & MATERIALS

- A. The MC shall be responsible for any and all equipment and materials to be installed under this contract, and he will be required to make good at his own cost any injury or damage which said equipment or materials may sustain from any source or cause whatsoever before final acceptance thereof.
- B. The MC shall be responsible for the protection of equipment and materials of others from damage as a result of work performed under this contract.

SECTION 15A, Page 7 MECHANICAL GENERAL INFORMATION

#### 15A.10 PROTECTION OF EQUIPMENT & MATERIALS (Continued)

C. All equipment for inside installations shall not be stored outside unless suitably covered and protected. All bearings shall be wrapped. No estimates for payment will be allowed for equipment not suitably protected.

#### 15 A.11 TIME OF WORK

- A. The contract contemplates doing the work during normal working hours and the MC shall arrange with the owner for times of doing work in specific areas. All work shall be programmed so as not to unduly interfere with the normal operations of the owners and tenants.
- B. Before turning off any facilities to make new connections the permission of the owner shall be obtained.

#### 15A.12 MANUFACTURERS' DIRECTIONS

All installations shall be made in strict accordance with the manufacturers' printed directions, and all equipment and materials called for by them shall be considered as a part of this contract.

#### 15A.13 RECORD DRAWINGS

- A. During the progress of the work, record all changes in locations of piping, tanks and any concealed work on a set of drawings kept specifically for that purpose.
- B. These shall be delivered to the engineer upon completion of the work and prior to the final payment.

#### 15A.14 DAMAGE BY LEAKS

The MC shall be responsible for all damage to any part of the premises caused by leaks or breaks in the work furnished and/or installed by him for a period of one year after date of acceptance of the work.

#### 15A.15 GUARANTEE

- A. The MC shall be responsible for all work done and materials installed under these contract documents. He shall repair or replace as may be necessary, at his expense, any defective work, material or parts which may show itself within one year of the date of final acceptance, if in the opinion of the owner said defect is due to imperfection of material or workmanship.
- B. In addition to the guarantees on workmanship and materials, furnish one copy of the manufacturers' guarantee on each piece of operating equipment.

#### 15A.16 SUBMITTALS

- A. Data shall be submitted to the engineer and his approval received on all items proposed for use if the equipment or material is different than that specified, prior to the installation of the items.
- B. Also see Section 15B:

#### 15A.17 COST BREAKDOWN

Submit to the owner a cost breakdown of major pieces of equipment and categories of work included in the contract, including labor to install, overhead and profit, but not sales tax.

#### 15A.18 PERFORMANCE BOND

If required by the owner, furnish a performance bond, the cost of which will be paid by the owner.

## 15A.19 INSURANCE

The insurance requirements of the owner are set forth in another part of the contract documents. Furnish the affidavit of insurance required.

#### 15A.20 SHOP DRAWINGS

Provide shop drawings and/or manufacturer's data sheets of all items, when in the opinion of the engineer they are necessary to obtain a satisfactory result.

#### 15A.21 MAINTENANCE & OPERATING INSTRUCTIONS

The preparation of maintenance and operating instructions is not a part of the contract; however, the contractor shall furnish to the engineer the manufacturers' data for maintenance, lubrication and operation.

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#### 15B.01 GENERAL

- A. Data shall be submitted to the engineer for approval on all items proposed for use if the equipment or material is different than that specified. Also, when required by the manufacturer, ordering approval sheets shall be submitted by the MC, even though the items may have been ordered by the owner or engineer.
- B. Price difference, if any, shall also be submitted with the request for approval.

#### 15B.02 COST BREAKDOWN

Submit to the owner, when requested, a cost breakdown showing the estimated amount of all work to be completed. This shall include all equipment, piping systems and related work, including labor to install, overhead and profit, but not sales tax.

#### 15B.03 EQUIPMENT & MATERIALS

- A. When requested by the owner, submit a list for approval of all equipment and materials proposed for use. Show all items included in the following list. If they are to be provided as specified write "Same" after the name of the item. If substitutions are proposed, give complete information.
- B. Material may be submitted at intervals. It is not necessary to submit all items at one time.
- C. Material submitted for approval shall be in 6 copies. 3 copies will be retained by the owner and 3 copies will be returned to the contractor.
- D. Each piece of literature submitted for approval shall be clearly marked as to the equipment proposed, giving complete information relative to manufacturer, catalog number, type and capacities, and also identified with the job name. Any material not properly identified must be resubmitted.
- E. MC shall not submit material without first having checked and approved it.
- F. Items other than those specified shall not be ordered until approval is received.
- G. If the materials are to be furnished the same as specified do not submit literature, unless it is for operating equipment or where approvals are required by the factory.

#### 15B.03 EQUIPMENT & MATERIALS

#### H. Submit on the following:

- 1. Types of pipe
- 2. Type of solder
- 3. Pipe supports and hangers
- 4. Isolating unions
- 5. Flexible piping and connectors
- 6. Strainers
- 7. Water make up valves
- 8. Backflow preventer
- 9. Valves gate, check, etc.
- 10. Air vents
- 11. Air traps
- 12. Thermometers
- 13. Gages
- 14. Escutcheons
- 15. Relief valves
- 16. Spray heads
- 17. Heat exchangers
- 18. Circulators and pumps
- 19. Compression tanks
- 20. Compression tank fittings
- 21. Gage glasses
- 22. Flow control valves
- 23. Flow meters
- 24. Water filters
- 25. Exhaust fan
- 26. Roof hood
- 27. Controls and instrumentation. See Section 15F.
- 28. Sump pump
- 29. Insulating materials
- 30. Coding, labels and tags

## 15B.04 SHOP DRAWINGS

- A. Provide shop drawings and/or manufacturer's data sheets of all items, when in the opinion of the engineer they are necessary to obtain a satisfactory result.
- B. Shop drawings and distribution shall be the same as for equipment and materials.

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## 15C.01 EXCAVATION & BACKFILLING

- A. Excavation for exterior tank installations and related piping will be by the GC.
- B. The MC shall do the necessary excavation for the pond recirculating piping along the exterior pond walls. Provide a sand fill in the trench so there are no voids under the pipe and the pipe rests solidly on the sand bedding. Backfill with sand to 2 inches over the pipe, then backfill with soil to within 1 foot of the top of the pond wall. Maximum rock size shall be 2 inches.
- C. After the tanks have been installed on the foundations and the insulation applied, the backfilling will be done by the GC allowing a minimum of 12 inch thickness sand backfill around all surfaces of the tanks. The remaining backfill will also be by the GC.
- D. The MC shall be responsible for backfilling to provide a firm bedding for all piping connecting to tanks and ponds. Piping shall rest in sand and shall have a minimum of 6 inch sand cover.
- E. After pipe installation is completed and sand backfilling installed, the remainder of the backfilling will be by the GC.
- F. Earth used for backfilling shall be moistened and compacted with all rocks larger than 4 inch being removed.
- G. Sand used for bedding shall be clean washed and dry.
- H. Coordinate with the EC to permit satisfactory installation of his conduit.
- Coordinate with the plumbing subcontractor to permit satisfactory installation of the domestic cold water service into the building.

# 15C.02 PIPING MATERIALS

# A. Type of Piping Systems

The MC shall provide the following types of piping systems:

1. Fiberglass for all collector piping mains above the roof, and in the attic, and in the basement. This includes all piping containing a glycol mixture, except the flexible connectors and the vertical display risers.

# 15C.02 PIPING MATERIALS (Continued)

# A. Type of Piping Systems (Continued)

- 2. Copper for all supply piping to spray ponds,
- 3. PVC plastic for pond recirculating lines and drain lines.
- 4. Copper for hot water heating and chilled water piping.
- 5. Copper for exterior piping connections to tanks.
- 6. Copper for domestic water piping.
- 7. Galvanized steel drainage piping for sump pump discharge.
- 8. Glass for display pipe risers. In viewing section these risers shall be equipped with visual flow indicators as specified later, and installed per detail.

# B. Standards

- Fiberglass reinforced epoxy resin pipe and fittings,
   A.O. Smith green thread or approved, per ASTM D-2105-67.
- 2. Copper pipe shall be type L, hard drawn per ANSI H23.1 (1970), with wrought copper or bronze fittings per ANSI B16.22 (1963).
- 3. Plastic pipe shall be PVC, standard weight, schedule 40, per ASTM D2665.
- 4. Steel pipe, galvanized or black, schedule 40, per ASTM A 120-73.
- 5. Glass pipe shall be Owens-Illinois, or approved Kimax.

# 15C.03 PIPE FABRICATION

#### A. General

- 1. Where changes in horizontal pipe sizes occur, use reducers. Bushings not permitted.
- 2. No bull head tees.

#### B. Fiberglass

Install per manufacturer's printed recommendations.

# C. Copper

Solder all joints with 430 solder, or as approved by the engineer.

#### D. Screwed

- 1. Ream free of burrs to full pipe size.
- 2. Pipe compound or tape applied to male threads only. A-17

# 15C.O3 PIPE FABRICATION (Continued)

# E. Welding

- 1. Black steel pipe may be welded, using welding fittings.
- 2. Welding fittings shall be Nibco or approved, and shall conform to same standards as pipe on which they are used.

# F. Plastic

Install per manufacturer's printed recommendations.

# G. Glass

Install per manufacturer's printed recommendations.

# 15C.O4 PIPE INSTALLATION

- A. Install exposed piping parallel or at right angles to adjacent surfaces.
- B. Hot water heating and chilled water piping run flat, but all lines must drain at low points and air out at high points.
- C. Provide adequate pipe supports and make provisions for expansion and contraction without excess stress.
- D. Where pipes go thru concrete walls the areas around the pipes shall be sealed with waterproof mastic, applied from both the exterior and interior surfaces. The interior surfaces shall be trowelled smooth, suitable for painting.
- E. Piping installed in the attic shall be supported from 2x4's fastened to the top chords of the trus-joists. Do not hang from the plywood decking.
- F. The MC shall provide the vertical copper pipe supports for the pond spray piping. These fit into existing pipe wells in the floors of the ponds. Provide shims so the support is vertical and secure. Seal remaining voids with white mastic. Provide a nylon saddle in the bottom part of the tee on top of the support so there is no metal to metal contact.
- G. The glass section and some connecting pipes of the vertical display piping shall be installed so it may be removed by lowering into the basement. Arrange valving, hangers and pipe locations so this is possible. Keep basement wall space clear below the vertical shaft opening so there will be no obstructions.

# 15C.04 PIPE INSTALLATION (Continued)

H. The sump pump discharge must connect into the existing 2 inch waste line just below the basement ceiling. Arrange piping so there are no interferences.

# 15C.O5 CLOSING OF OPENINGS

- A. All openings in pipes shall be kept closed during the progress of the work to keep piping free of foreign material. This is a MUST at the end of each day's work.
- B. Copper or steel pipe shall be closed with screwed caps or plugs.

#### 15C.06 PIPE SUPPORTS

- A. Provide all necessary hangers and pipe supports.
- B. Hangers shall be located at base of risers, at each change of direction of more than 5 feet, and shall be spaced not more than 10 feet centers. Provide additional hangers where necessary for extra loads such as pumps and valves.
- C. Copper piping shall be hung with copper hangers.
- D. No perforated metal strap hangers shall be used in any finished area.
- E. The MC shall provide the angle supports for the collector header piping above the roof per detail B on Sheet M-6.
- F. The MC shall provide supports for all piping and equipment in the basement. Provide Unistrut or approved racks or ceiling channels, secured to concrete with expansion shield lag screws shot into the existing concrete ceiling and walls.
- G. Suspended piping shall be hung with Grinnell or approved No. 104, adjustable, swivel, split ring rod hangers.

#### 15C.07 ANCHORS

- A. Provide necessary anchors.
- B. Submit details for approval if requested by the engineer.

# 15C.08 FLASHING

All piping passing thru roofs shall be installed per detail. See Section 15E.

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PIPING & ACCESSORIES

# 15C.09 UNIONS

Provide unions where shown, or where necessary to facilitate future maintenance or repairs.

# 15C.10 ISOLATING UNIONS

Wherever two metallic pipes of dissimilar materials are joined provide a plastic pipe union or a commercial product dielectric union to prevent corrosion caused by galvanic or electrolytic action.

# 15C.11 FLEXIBLE PIPING AND CONNECTORS

- A. The flexible pipe connectors between the solar collector plates, and between the collectors and the mains above the roof, including the straps and fastening devices, have been prepurchased by the owner. The MC shall make all installations.
- B. Where shown in the pond piping and as shown or required in the attic and roof piping, provide Anaconda or approved flexible hose, standard weight, corrugated stainless steel, type LW21-1.
- C. For base mounted pump connections on intake and discharge and elsewhere as shown, provide Anaconda or approved, same material as specified above.

# 15C.12 STRAINERS

On the inlet side of each motorized valve pump and elsewhere as shown, provide a Y type strainer, Trane or approved, with valved drain connection.

# 15C.13 WATER MAKE UP VALVES

- A. Provide on each cold water make up service a B&G or approved automatic water feeder with pressure regulator, strainer and relief valve. Provide a by-pass with manual gate valve.
- B. On the roof glycol piping system provide a funnel with a 2-inch valved connection to the main for initial filling from a ground level portable pump.

# 15C.14 BACKFLOW PREVENTER

On the water feed line to the solar system provide a Watts or approved No. 700 double check valve assembly with strainer, all bronze with stainless steel internal parts, per A.S.S.E. Standard 1015.

# 15C.15 VALVES

A. Provide a valve on the intake and discharge of each piece of equipment, pump, regulator, coil, and elsewhere as shown.

# B. Gate - 2" and Smaller

Nibco or approved, S-22 or T-22, bronze body, Teflon plunger, wheel handle, non-rising stem.

# C. Gate - Larger than 2"

Nibco or approved, S-113 or T-113, 125# S.W.P. bronze body, non-rising stem, wheel handle, solid wedge.

#### D. Globe Valves

Nibco or approved S-213 or T-213, 125# S.W.P., bronze body, Buna-N disc, wheel handle, non-rising stem.

# E. Check Valves

Nibco or approved, S-413 or T-413, 125# S.W.P., bronze body, Teflon disc, horizontal swing, Y pattern.

# F. Ball Valves

Nibco or approved, S-590 or T-590, 150#, cast bronze body, bronze ball, reinforced Teflon packing and washer.

G. For control valves see Section 15F.

#### 15C.16 AIR VENTS

- A. Provide at the discharge connection of each collector bank a Dole or approved, No. 9 screw driver type manual air vent, installed in a short nipple between the collector outlet and the flexible hose connection.
- B. Provide a similar air vent at the high point of each piping system, including the heating-cooling coils in the heat pump units.
- C. No automatic air vents are contemplated.
- D. If the vents are in an inaccessible location, provide a 1/4 inch copper tube from the high point to an accessible location and provide an air vent on the end of the line. Such lines shall be as short as possible and shall be run in a neat manner and securely fastened.

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# 15C.17 AIR TRAPS

Provide B&G or approved, Rolairtrol air separator, ASME Construction, 125# W.S.P.

# 15C.18 FLOW MEASURING DEVICES

These are installed in the piping system. See Section 15F.

# 15C.19 FLOW SWITCHES

These are installed in the piping system. See Section 15F.

# 15C.20 THERMOMETERS

Trerice or approved, 7" aluminum case, adjustable, separable socket, 30° - 240° F.

# 15C.21 GAGES

Trerice or approved, No. 890, 3-1/2 inch stainless steel case, 10 inch vacuum, 50# pressure.

# 15C.22 ESCUTCHEONS

Provide chrome plated split ring escutcheons with set screws where pipes go thru walls or ceilings of finished spaces, providing there is sufficient space around the pipe, otherwise see the engineer.

#### 15C.23 SPRAY HEADS

- A. The MC shall provide all spray heads for the pond installations, half heads and full as required.
- B. As directed by the engineer, the MC shall procure and install 4 or 5 types of heads to determine the one most suitable for use. Cap or plug the remainder of the outlets during the test period. After a selection is made, the remainder of the heads shall be installed.

# 15C.24 INSTRUMENTATION FITTINGS

The MC shall provide all necessary fittings, nipples, flanges, adapters, etc. that are required for the installation of instrumentation devices in the locations shown on the drawings and in the schedule.

# 15C.25 CIRCUIT SETTERS

- A. Provide on each branch circuit of the collector system, on each branch circuit to the heating-cooling coils in the heat pumps and elsewhere as shown, B&G or approved, circuit setter balancing valve, sized as indicated.
- B. Provide one differential meter model #RO-1.
- C. Retain the polyurethane packing boxes for insulation of the circuit setters in the final installation.

# 15C.26 TESTS

All tests shall be conducted in accordance with City of Richland requirements.

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# 15D.01 UNDERGROUND TANKS

- A. Provide underground water storage tanks, constructed substantially per details, including welded steel base supports, necessary tappings, manhole, manhole frame collars, lifting lugs, and brackets for interior pipe supports. The interior piping will be field installed.
- B. Tanks shall be manufactured by Welk, or approved, conforming to ASME and UL standards.
- C. Tanks shall be air pressure tested to 15 PSI, with a certified report.
- D. Tank No. 1 for hot water storage shall have a capacity of 9,000 gal., and tank No. 2 for chilled water storage shall have a capacity of 2,000 gal.
- E. Tank interiors shall be given a minimum of 5 coats of baked epoxy-phenolic resin. Exterior shall be given one shop coat of asphalt primer and one additional coat at the site.
- F. See other sections for tank insulation and installation.
- G. Submit shop drawings.

#### 15D.02 TANK MANHOLES

- A. Provide concrete manholes between the underground tanks and grade, constructed substantially in accordance with the details using concrete or masonry blocks, precast tapered sections and precast riser rings as required.
- B. For metal frame on top of tank see Section 15E.
- C. The square sections above the thermal energy storage tank shall be 48 inch x 48 inch inside dimensions. The rectangular sections over the chilled water tank shall be 30 inch in the north-south direction and 36 inch in the east-west direction.
- D. These sections, to a minimum of approximately 12 inches above the tanks, shall be installed as soon as the tanks are in place and before the insulation is applied. Leave openings for pipe and conduit installations.
- E. After pipe and conduit have been installed, grout and seal openings watertight.

SECTION 15D, Page 2 MECHANICAL SOLAR SYSTEM & RELATED EQUIPMENT

# 15D.02 TANK MANHOLES (Continued)

- F. Manhole covers shall be "OLYMPIC" Foundry Co., no substitute accepted, No. 5823, lid style B. 24 inch dia., 4 inch deep.
- G. Contractor may build manholes per telecon, 20 Oct 76, 2:00 p.m., per DCG.

# 15D.03 SOLAR COLLECTORS

- A. The solar collectors are being furnished by General Electric. Each collector has a 3/4 inch OD by 2 inches long aluminum nipple at each corner for flexible hose connections.
- B. The mounting hardware and the holding frames on the roof will be by others and will not be a part of the work by the MC.
- C. The MC shall pick up the collectors with the attached mounting hardware, from the owners' warehouse, and set the collectors in the appropriate locations as detailed, including the transportation and hoisting. The fastening pins will be furnished by the owner.
- D. The collector setting angle shall be as directed by the owner.

# 15D.04 WATER FIRED CHILLER

- A. The Arkla water fired, water cooled chiller has been prepurchased by the owner.
- B. The MC shall pick up the unit at the point of delivery in Richland and shall deliver it to the job site. He shall also uncrate and lower the unit into the basement, set it in place and make all final connections.

# 15D.05 HEAT PUMP WORK

A. The alterations to the heat pump fans and motors, alterations to the styles, packages, and the installation of heating-cooling coils in the packages has been previously authorized by the owner to the GC and this work and the installation of the equipment is not included as a part of the work covered by this solar specification.

SECTION 15D, Page 3 MECHANICAL SOLAR SYSTEM & RELATED EQUIPMENT

# 15D.05 HEAT PUMP WORK (Continued)

B. The MC shall make all hot water and chilled water piping connections to the heating-cooling coils.

# 15D.06 HEAT EXCHANGERS

MC shall provide heat exchangers HX-1 and HX-2, B & G or approved, ASME code construction. See the schedule for data.

# 15D.07 DOMESTIC WATER PREHEATER

- A. A domestic water solar generated preheater has been prepurchased by the owner from National Steel Construction Co.
- B. See the schedule for capacities and characteristics.
- C. The MC shall pick up at the point of delivery in Richland, transport to the job site, uncrate, install in basement and make all final connections.

# 15D.08 COMPRESSION TANKS

- A. Provide compression tanks National or approved, ASME code with tappings for gage glass and tank fittings.
- B. See schedule for data.

# 15D.09 COMPRESSION TANK FITTINGS

Provide on each tank an Airtrol tank fitting B & G or approved, series ATF, sized to suit tank.

# 15D.10 GAGE GLASSES

Provide on each compression tank an Ernst or approved, Fig. 5-0 bronze gage and glass assembly for 175# pressure.

# 15D.11 CIRCULATING PUMPS

- A. Provide circulating pumps, B & G or approved, base mounted or in-line as indicated.
- B. See schedule for capacities and characteristics.

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SOLAR SYSTEM &
RELATED EQUIPMENT

# 15D.12 GLYCOL PUMP

- A. Provide goulds or approved, all iron.
- B. See schedule for capacities and characteristics.

# 15D.13 GLYCOL TANK

- A. Provide a 16 ga galvanized steel, non pressure, glycol fill tank, welded construction, hinged top. Paint all welds with Galvaweld.
- B. See detail for construction features.

# 15D.14 EQUIPMENT FOUNDATIONS & SUPPORTS

- A. Concrete equipment bases and bolts in the basement, will be provided by the GC.
- B. The MC shall give the GC all necessary dimensional data.
- C. Any other isolation bases or leveling material shall be the responsibility of the MC.
- D. Supports and racks for tanks, in line pumps and other equipment, whether floor, wall or ceiling mounted shall be the responsibility of the MC.
- E. See details for construction features.

# 15D.15 VIBRATION ISOLATION BASES

Under the base-mounted pumps provide Korfund or approved Korpad No. 60, 1/4 inch thickness.

#### 15D.16 WATER FILTERS

- A. On the circulating lines from the spray ponds provide Cuno or approved cartridge type filters, 150 psi ASME construction housing noncertified.
- B. See schedule for capacities and characteristics.

# 15D.17 FLOW INDICATORS

The MC shall provide flow indicators in the vertical up feed risers in the display case, as indicated.

# 15D.17 FLOW INDICATORS (Continued)

- A. Eugene Ernst Products Co. (EEP), or approved, Model EEP 960-F, 150 LB. standard flanged ends.
- B. Units on copper lines shall be bronze and on fiberglass shall be carbon steel.

# 15D.18 LIQUID LEVEL CONTROLS

- A. For each pond provide a liquid level controller, Warrick or approved. No. 3E2B with two brass electrodes type 3R, no sheath. Housing shall be NEMA 4.
- B. Fasten to side of pool with lag bolts and flange on tee in pipe extension below controller. See detail.
- C. Electrical work not by MC.

# 15D.19 POND GRATINGS

- A. Provide grating enclosures around pond circulating outlets and around liquid level controllers per details, constructed of No. 316 stainless steel.
- B. Enclosures shall have hinged tops and shall be lagged to sides and bottoms of ponds.

# 15D.20 COLLECTOR AIR VENTS

The owner will furnish and install saddle values, to be used as air vents, on the top end connection in each row of collectors.

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# MECHANICAL

# SECTION 15E - SHEET METAL & VENTILATING EQUIPMENT

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15E.04	PIPE SHAFT ENCLOSURE	2	9 Nov 76
15E.05	DUCT TAPE	2	
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15E.08	REMOTE CONTROLLED DAMPERS	2	
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# 15E.01 MANHOLE FRAME SUPPORT FOR UNDERGROUND TANKS

For each of the underground water storage tanks provide 2 holding frames for the concrete block manholes. These shall be constructed of 20ga G.I., and shall be in the form of a 2 inch x 2 inch angle, curved to fit the curvature of the tank and capable of supporting the 4 inch thick concrete block manholes. Obtain size and details from the GC.

# 15E.02 EXHAUST FANS

- A. The exhaust fans from the toilets, janitor's room and the electrical room are not a part of the solar work.
- B. Under this solar work the MC shall provide two exhaust fans in the attic, one serving the shop in the southwest corner of the building and one exhausting from the vertical pipe shaft in the display area.
- C. These units shall be Pace or approved, with spring isolators, and suspended from truss-joists, not from the roof deck.
- D. See the schedule for data.

#### 15E.03 DUCT MATERIALS & INSTALLATION

- A. All sheet metal work, except as otherwise specified or noted shall be new galvanized iron of the gauges recommended for low pressure ducts in the latest SMACNA manual.
- B. Prior to fabrication verify all duct locations and dimensions. Also verify cross members in joists or trusses. If structural conditions or other obstructions require changing the shape or location of the ducts from those shown on the drawings, the contractor shall make the necessary revisions with no increase in cost to the owner.
- C. Where fire dampers occur the duct shall be enlarged so there is no restriction in duct area due to damper or frame. Access openings shall be provided at all fire dampers.

SECTION 15E, Page 2
MECHANICAL
SHEET METAL &
VENTILATING EOUIPMENT

# 15E.03 <u>DUCT MATERIALS & INSTALLATION</u> (Continued)

- D. Where ducts go thru roof, secure duct to curb and provide counter flashing. Seal with Alumilastic.
- E. Check the location of light fixtures and tile pattern before installing any ceiling outlets. The sheet metal openings shall be located to form a uniform pattern.

# 15E.04 PIPE SHAFT ENCLOSURE

At the top of the vertical pipe shaft provide a plenum extension the full size of the shaft and approximately 3 ft. high. Seal all areas at the top of the shaft and around pipes so there is no air leakage. Provide duct connection from this shaft to the exhaust fan intake. Shaft extension shall be 18 ga. G.I.

# 15E.O5 DUCT TAPE

Where tape is necessary to make air tight joints, seal with 3M #474, or approved, applied in a workmanlike manner with all edges and ends secured.

# 15E.06 FLEXIBLE CONNECTIONS

A. The connections between each fan unit and the duct work shall be made with Vent fabrics, or approved, Ventfab, 20 oz per square yard, UL approved, of a weight not lighter than 2-1/2 lb. per square yard, held in place by galvanized iron bands not lighter than 1-1/4 inch by 24 gauge.

# 15E.07 FIRE DAMPER

Provide a UL approved fire damper, with duct access opening, in the duct leaving the pipe shaft plenum.

# 15E.08 REMOTE CONTROLLED DAMPERS

- A. Install the motor operated dampers in sheet metal connection for EF-1 and EF-2.
- B. The dampers and controls are specified in Section 15F.

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SHEET METAL &
VENTILATING EOUIPMENT

# 15E.09 ROOF HOODS

- A. On exhaust fan discharges provide Pace or approved roof hoods, rectangular, fiberglass construction, color as selected by owner.
- B. See schedule for sizes.
- C. Set in Alumilastic. Provide counter flashing.

# 15E.10 SHOP EXHAUST GRILLE

Provide plastic egg crate exhaust grille similar to return grille in the shop ceiling.

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# MECHA NICAL

# SECTION 15F - CONTROLS & INSTRUMENTATION

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15F.04	REMOTE CONTROLLED VALVES	1	
15F.05	REMOTE CONTROLLED DAMPERS	2	11 Nov 76
15F.06	DESCRIPTION OF CONTROL FUNCTIONS	2	

# 15F.01 SCOPE OF WORK

- A. The heat pump controls and the return air stats are being done by the MC as a part of the basic building HVAC system and are not a part of this solar system installation.
- B. Instrumentation for Solar System
  - The instrumentation devices that are to be installed in piping, tanks or duct work are being furnished and delivered to the job site by ERDA. The MC shall install these devices in the locations indicated.
  - 2. Instrumentation devices pertaining to power and electrical recordings will be installed by the EC. The EC will do all electrical work in connection with instrumentation devices installed by the MC.
- C. The motor operated valves in the solar piping system and their control devices shall be provided by the MC, including the low voltage wiring required for their operation. The motor operated valve in the Arkla unit is prewired as a part of the package and there is no work by the MC.
- D. Manual switches for control of fans, pumps, valves, dampers, etc. will be provided by the EC.

#### 15F.02 SHOP DRAWINGS

Control drawings and descriptions of operations are included as a part of the contract documents. If the contractor desires to make revisions, he shall submit shop drawings of the proposed revisions, and obtain approval, including price change, if any, before proceeding with the work.

# 15F.03 ELECTRICAL WORK BY MC

All low voltage electrical work performed by the MC shall be per NEC and requirements of the City of Richland.

# 15F.04 REMOTE CONTROLLED VALVES

- A. Provide remote controlled valves in the solar related piping systems, Honeywell, or approved, 24 volt.
- B. See the schedule for data.

# 15F.05 REMOTE CONTROLLED DAMPERS

Provide remote controlled dampers, Honeywell or approved, parallel blades, on the discharge of EF-1 and in the recirculation and exhaust ducts from EF-2.

# 15F.06 DESCRIPTION OF CONTROL FUNCTIONS

ITEM	SERVICE	OPERATIONS	
P-1	Glycol piping on line between HX-2 and inlets to solar collectors	TS-1 on the solar collector array, energizes P-I if the temperature is greater than 180 degrees F. with no zones calling for heating. TS-2 on the solar collector array, energizes P-I if the temperature is greater than 120 degrees F. with no zones calling for cooling.	
P-2	On hot water supply line to Arkla unit	P-2 is energized with P-1, or by a demand from the Arkla unit.	
P-3	Hot water heating feed line to heating-cooling coils at heat pumps	P-3 is energized if any zone is calling for heat.	
P-4	Chilled water feed line to heating-cooling coils at heat pumps	_	
P-5	On circulating line from ponds into Arkla unit condenser	P-5 is energized with Arkla unit.	

# 15F.06 DESCRIPTION OF CONTROL FUNCTIONS - Continued

ITEM	SERVICE	OPERATIONS
P-6	On hot water line from TES tank to domestic hot water heat exchanger	P-6 is energized if the TES tank temperature is more than 12°F. above the domestic hot water temperature in HX-3, and deenergized when the temperature differential falls to 3°F. P-6 is also deenergized if the domestic hot water in HX-3 is more than 160°F.
P-7	On line from over temperature control HX-1 to cooling ponds	P-7 is energized when the TES tank temperature reaches 230°F. and is deenergized when the TES tank temperature drops to 220°F.
V-1	Positive shut off on Arkla unit firing coil discharge to HX-2	V-1 is 2 position and closes on Arkla shutdown.
V-2	3-way, 2 position valve on by-pass around HX-2	ClA/ClB comparator controls V-2. ClA is in solar collector line between HX-1 and HX-2. ClB is in the hot water return line to HX-2. When ClA temperature rises to 20° above ClB, V-2 moves to "A" flow. When ClA temperature drops to 3° above ClB, V-2 moves to "B" flow.
V-3	3-way modulating valve on line from TES tank and feed to P-2 or V-5	With flow thru "A" port of V-2, C3A or C3B reverse modulates V-3 to store excess heat. With flow thru "B" port of V-2, C3A or C3B modulates V-3 to use TES tank heat.

# 15F.06 DESCRIPTION OF CONTROL FUNCTIONS - Continued

<del></del>		
ITEM	SERVICE	OPERATIONS
V-4	diverting/ 3-Way modulating valve on hot water feed to heating-cooling coils	Prewired at Arkla factory. Bypass around water fired coil.
V-5	3-Way modulating valve on hot water feed to heating-cooling coils.	"A" and "B" ports modulated by C5B in hot water feed line, which is reset by outside air sensor C5A.
V-6	One modulating by-pass valve on each heating-cooling coil	Modulated by return air zone stat.
V-7	2 position valves. 4 at each heating-cool- ing coil. (a) Heating feed (b) Heating return (c) Chilled water feed (d) Chilled water re- turn	a and b valves open on heating cycle. c and d valves open on cooling cycle.

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# MECHANICAL

# SECTION 15G - PLUMBING

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15G.01	GRAVITY POND DRAINS	1	11 Nov 76
15G.02	SUMP PUMP	1	
15G.03	DRAINAGE PIT & COVER	1	
15G.04	FLUSH CLEANOUTS	1	

# 15G.01 GRAVITY POND DRAINS

Provide in each pond a gravity drain with standpipe overflow, Zurn or approved No. Z-114, 2 inch size, set in pond floor. Two-inch threaded standpipe shall be 18 inches ("J" dimension) above pond floor, non-perforated, with cap. Entire assembly shall be Duracoated.

# 15G.02 SUMP PUMP

Provide Paco or approved No. PIP-703, submersible type with 15 foot cable length, 85 GPM at 15 foot head, 2 inch discharge size, automatic level controls, oil filled 1/2 HP motor, 115 V. single phase. Pump must fit into existing drainage pit.

# 15G.03 DRAINAGE PIT & COVER

- A. The drainage pit has been previously installed.
- B. The MC shall provide a removable slotted cover to permit pump removal, and installation of drain pipes.
- C. Material may be wood if desired. Obtain approval of engineer.

#### 15G.04 FLUSH CLEANOUTS

Provide flush cleanouts in walk, where shown, on circulating pond line, Zurn or approved No. 2455-6, 2 inch pipe size, round scoriated top, machine finish bronze.

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# SECTION 15H - INSULATION

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# 15H.01 GENERAL

- A. Refer to other parts of the specifications for items that are applicable to work under this section.
- B. Provide insulation installed by experienced workmen.
- C. The materials specified constitute a standard required. Other materials submitted for approval shall be equal to or better than those specified.
- D. Prior to insulating remove all rust, scale or debris from surfaces to be covered.
- E. Pipe insulation shall not be banded.
- F. At each hanger location use a rigid section of insulation.
- G. All insulation shall be applied per manufacturer's printed directions.
- H. Insulate valves, unions, flanges, etc.
- I. Prior to final acceptance of the work, repair or correct all insulation that might have been damaged during construction and make all joints tight and tape ends secure so the installation is a finished product in all respects.

# 15H.02 UNDERGROUND TANKS

- A. The 9,000 gallon thermal energy storage tank and the 2,000 gal. chilled water storage tank shall be insulated with 3 inches of sprayed-on Urethane by Vertecs, or approved, and coated with 15 mil Diathon.
- B. Insulate exterior of manhole covers approximately 12 inches above the tanks, but do not insulate inside the manholes.

# 15H.03 UNDERGROUND PIPING

Insulate underground hot water and chilled water piping between the south building wall, and the ponds and tanks, with Armstrong, or approved, Armaflex tubular type, with a thickness shown on the schedule on sheet M-11. If necessary to slit tubular insulation, seal with factory approved adhesive. Cover straight horizontal runs of piping with an aluminum jacket or other methods approved by the engineer, to prevent crushing of insulation.

# 15H.04 OTHER PIPING INSULATION

- A. Provide interior and exterior pipe insulation, Armstrong or approved, Armaflex tubular type, sealed with #520 adhesive. Finish shall be Armaflex vinyl lacquer type coating of a color selected by the owner.
- B. Thicknesses shall be as follows:
  - 1. All fiberglass and flexible piping above the roof, including the nipples on the solar collector plates, use 3/4 inch.
  - 2. Solar collector piping in the soffit overhang, in the attic space, the vertical risers between the basement and attic, and in the basement connections to HX-1 and HX-2, use 3/4 inch.
  - 3. All piping in the basement connecting HX-2, the TES tank and the Arkla unit, use 3/4 inch.
  - 4. Basement piping from HX-1 going to the cooling ponds, use 3/4 inch and returning from the ponds, use 3/8 inch.
  - 5. Basement piping from the TES tank to V-3, use 1/2 inch.
  - 6. Basement piping in connection with the heating side of HX-3, use 1/2 inch.
  - 7. Domestic water piping from the valved take off from the 2 inch main in the basement to all connections to the solar system and to HX-3, use 3/8 inch.
  - 8. Domestic water from HX-3 to the electric heater on the first floor, and the return circulating line, use 1/2 inch.
  - 9. Basement piping from the Arkla unit to HX-3 and the cooling ponds, use 1/2 inch and on the return from the ponds, use 3/8 inch.
  - 10. All piping in the basement, the vertical risers, and in the attic in connection with the hot water heating feed and returns and the chilled water feed and returns, use 1/2 inch.

# 15H.05 EQUIPMENT INSULATION

- A. Equipment in the basement shall be insulated with Armstrong or approved, Armaflex sheet insulation, using 520 adhesive and a vinyl lacquer type coating of a color selected by the owner.
- B. Thicknesses shall be as follows:
  - 1. HX-1 and HX-2, use 3/4 inch
  - 2. HX-3, use 1/2 inch
  - 3. Compression tanks, use 1/4 inch
  - 4. Air separators, use same thickness as connecting pipe insulation

END OF SECTION 15H

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# MECHANICAL

# SECTION 15I - COMPLETION WORK

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15I.O3	CLEAN UP			1	

# 15I.01 LABELS

- A. Provide labels or tags to properly identify each piece of equipment, valve, switch and control items installed under this contract.
- B. In addition, provide a numbered tag for each manual valve.

  Numbers will be assigned by the owner.
- C. Labels and tags shall be brass, phenolic or other approved permanent material. Paper or cloth material will not be accepted.
- D. Valve tags shall be fastened to stems and not to handles.

# 15I.02 PAINTING

Paint all metal equipment supports, racks or frames one coat of Rustoleum of a color selected by the owner.

#### 101.03 CLEAN UP

- A. Remove all unused material and debris occasioned by this work including that on roofs, in attic spaces and in mechanical rooms.
- B. Clean all new equipment, patch paint chips or scratches and leave in a dust-free condition.

# ADDENDUM NO. I





# SPECIFICATIONS FOR MECHANICAL WORK PROJECT SUNBURST Issued By OLYMPIC ENGINEERING CORPORATION 20 December 1976

# 1. 15A.01 DEFINITIONS - REFERENCES

Add "H, The term "ERDA" shall mean the Energy, Research & Development Administration".

- 2. 15C.02A.1., In last sentence, put a period after "connectors.", and delete "and the vertical display risers."
- 3. 15C.02A.3. Change "PVC" to "DWV".
- 4. 15C.02A.8. Delete entire paragraph.
- 5. 15C.02B.5. Delete entire paragraph.
- 6. 15C.04E. Add "Unistrut members may be used in lieu of 2 x 4's."
- 7. 15C.04G. Delete entire paragraph.
- 8. 15C.12 Insert a comma between "valve" and "pump".
- 9. 15C.26 Add "All piping shall be air pressure tested to 75 lbs. for a 15 min. period with no drop in gage reading. Notify engineer prior to each and obtain his certification."

# 10. Add: "15C.27 PETE'S PLUGS

Where thermometers and gages are shown on the drawing the MC shall install Pete's Plugs, and shall provide a total of 5 each thermometers and gages. These shall not replace instrumentation devices."

- 11. 15D.06 In second line correct spelling of "approved".
- 12. 15D.07 DOMESTIC WATER PREHEATER Add "(HX-3)".
- 13. 15D.12A. Change second word to "Goulds".
- 14. 15D.17 FLOW INDICATORS Delete entire section.
- 15. 15D.20 Change "values" to "valves".



- 16. 15E.02B Change paragraph to read: "Under this solar work the MC shall provide one exhaust fan in the attic, exhausting from the vertical pipe shaft in the display area, Pace or approved, with spring isolators, and suspended from trussjoists, not from the roof deck. The shop exhaust fan is not a part of the solar work.
  - C. Delete paragraph C.
- 17. 15E.08A. Delete "EF-1 and".
- 18. 15E.09 ROOF HOODS Delete entire section.
- 19. 15E.10 SHOP EXHAUST GRILLE Delete entire section.
- 20. 15F.05 REMOTE CONTROLLED DAMPERS Delete "on the discharge of EF-1 and".
- 21. Add "15G.05 HOSE BIBB

MC shall provide a hose bibb on the roof adjacent to the ambient temperature station. This shall be connected to the 2-inch domestic cold water line in the attic. Provide a 3/4 inch stop and waste in the attic. Insulate with 3/8 inch.

END ADDENDUM NO. I

# CONTENTS OF SUNBURST MAINTENANCE MANUAL MANUFACTURERS' INSTALLATION AND OPERATING INSTRUCTIONS

AQUA-PURE SS-4, SS-8, SS-12 FILTERS

ARKLA SOLAIRE 300 ABSORPTION CHILLER

BELL & GOSSETT AFB, ABF, ABF-SO, ATFL-1", ABF-6" 1AF "AIRTROL SYSTEMS

BELL & GOSSETT TYPE IAF IN-LINE AIRTROL AIR SEPARATORS

BELL & GOSSETT 16" SERIES TYPE WU HEAT EXCHANGERS

BELL & GOSSETT 10" SERIES TYPE WU HEAT EXCHANGERS

BELL & GOSSETT SERIES 80 IN-LINE MOUNTED CENTRIFUGAL PUMPS

BELL & GOSSETT SERIES 60 IN-LINE MOUNTED CENTRIFUGAL PUMPS

BELL & GOSSETT SERIES 1510 BARE-MOUNTED CENTRIFUGAL PUMPS

BELL & GOSSETT VO2125 CIRCUIT SETTER BALANCE VALVES

BROD & McCLUNG -PACE UNIT 79 SMALL CABINET FANS

BURLING TEMPERATURE CONTROL SWITCHES

CARRIER 50D0006, 50D0008 HEAT PUMP WEATHER MAKER

GOULDS MODELS 3642 AND 3656 CLOSE COUPLED CENTRIFUGAL PUMPS

HONEYWELL T991A PROPORTIONAL TEMPERATURE CONTROLLERS

HONEYWELL 130810 B COVER TRANSFORMER

HONEYWELL T991B DUAL BULB TEMPERATURE CONTROLLER

HONEYWELL V 5013 B, V5013 C NON-SPRING RETURN (VALVE CONTROL) MOTORS

HONEYWELL T 4031 A,B, T 6031 A,B REFRIGERATION TEMPERATURE CONTROLLERS

HONEYWELL V 5013A-C THREE-WAY VALVES

HONEYWELL M 644A-G, J-L MODUTROL (VALVE) MOTORS

HONEYWELL M 644A-F MODUTROL (VALVE) MOTORS

HONEYWELL V5011 A, B & C AND V5013 A, B, & C VALVE BODIES

HONEYWELL V 5013A-C THREE-WAY MIXING & DIVERTING VALVE BODIES

PACO MODELS PIP 700, 701, 702, 703 SUBMERSIBLE SUMP PUMPS

RUBATEX TUBING AND PIPE INSULATION

# APPENDIX B

PROJECT SUNBURST
START-UP PROCEDURES
AND
FUNCTIONAL ACCEPTANCE TESTS
'HEATING SYSTEM
'COOLING SYSTEM

# APPENDIX B

# PROJECT SUNBURST START-UP PROCEDURES AND FUNCTIONAL ACCEPTANCE TESTS

# INTRODUCTION

This appendix has been included as supplemental information for Sections 3.0 and 4.0 of this report and consists of two separate Olympic Engineering Corporation documents. The first is a start-up procedure which also serves as an acceptance test check list for the Project Sunburst Solar Heating System acceptance test. The second item is a similar report for the Project Sunburst Solar Cooling System. Acceptance tests were conducted by Olympic's Robert Poplin with the heating system test being completed on March 1, 1978 and the cooling system test being completed on April 26, 1978.

# OLYMPIC ENGINEERING CORPORATION 3070 GEORGE WASHINGTON WAY RICHLAND, WASHINGTON 99352

PROJECT SUNBURST

SOLAR HEATING

START-UP PROCEDURE

and

FUNCTIONAL ACCEPTANCE TEST

Prepared by\_

February 10, 19/8

# 1.0 SCOPE

This procedure covers the necessary steps required to fill the solar glycol system and the solar heating system and perform the necessary checkout of the system to start-up the solar heating system of Project Sunburst. This procedure does not cover the start-up of the chilled water system.

#### 2.0 APPLICABLE DOCUMENT

# 2.1 Drawings

- 2.1.1 7608-M-3 Rev 5 Basement and Attic Section amd Miscellaneous
- 2.1.2 7608-M-4 Rev 8 First Floor Plan Ponds
- 2.1.3 7608-M-5 Rev 4 Attic Plan
- 2.1.4 7608-M-6 Rev 7 Roof Plan
- 2.1.5 7608-M-7 Rev 7 TES Tank
- 2.1.6 7608-M-10 Rev 5 Miscellaneous Details (Schedules)
- 2.1.7 7608-M-11 Rev 4 Underground Piping
- 2.1.8 7608-M-12 Rev 3 Schematic Flow Diagram
- 2.1.9 7608-M-16 Rev O Solar Basement Plans and Miscellaneous
- 2.1.10 6039 E-3-1 Rev O Basement Power Pwr Misc Circuits
- 2.1.11 6039 E-3-2 Rev 2 Basement Power Control Circuit
- 2.1.12 6039 E-3-3 Rev O Basement Power Wiring Diagram
- 2.1.13 6039 E-3-4 Rev O Basement Power Panel G Connection

# 2.2 Specifications

2.2.1 Project Sunburst solar demonstration specification for mechanical work dated 12 October 1976.

# 2.3 Manuals

- 2.3.1 Doc. No. OMM-1 Jan 1977 Solar System Operation and Maintenance Manual.
- 2.3.2 SD Doc. No. 76SDS4281 Jan 1977 Solar Heating and Cooling System Design

# 3.0 SOLAR SYSTEM DESIGN

- 3.1 Project Sunburst solar system consists of the following major elements:
  - a) A pressurized closed loop, roof mounted, flat plate collector array containing ethylene glycol for freeze protection. It includes a shell and tube heat exchanger to isolate the glycol loop from the water in the storage and utilization circuits.
  - b) Pumps, heat exchangers, control valves, expansion tanks, etc.
    located in a mechanical room beneath the south entrance lobby.
  - c) Hot water and chilled water thermal energy storage tanks buried beneath the south entrance walkway.
  - d) Interconnecting piping.
  - e) An automatic solar control system which utilizes energy directly from the main heat exchanger and stores the excess. The controls are interfaced with the conventional heat pump HVAC installation and are designed to utilize solar inputs as the prime energy source.

# 3.2 Solar Collector Loop

The solar collector loop consists of 252 General Electric FP-2 double window flat plate collectors. The array is arranged in 13 rows varying in lengths from 21 collectors in the full rows to 17 collectors in the rows interrupted by the centrally located heat pump array.

A reverse return manifold system design provides an east and a west bank of collectors each containing 13 rows varying in length from 8 to 12 collectors. Each row of the two banks contains a circuit setter valve to facilitate the rapid measurement and balancing of system flow rates.

# 3.3 Energy Storage and Utilization Loop

The solar energy storage and utilization loop includes the thermal energy storage tanks and modulating by-pass valve, solar domestic hot water heater circuit, an economizer heat exchanger to preheat the solar domestic hot water, the main heat exchanger with by-pass valve and the primary pump loop that supplies hot water for heating and cooling. Solar cooling is accomplished with an Arkla absorption water chiller coupled to a chilled

water storage tank. This storage tank acts as a thermal capacitor and thereby reduces cycling during low load periods.

The solar/conventional HVAC system interface occurs in each of the eight zone heat pump assemblies. A combination solar heating/cooling auxiliary coil, located in each heat pump air handler, is connected and valved to both the hot and chilled water manifolds. This selectively permits either heating or cooling in each of the eight zones. In addition to scheduling heating system supply temperatures based on outside air conditions, each coil has individual modulating by-pass valves to provide maximum comfort-control in each zone.

# 4.0 HEATING SYSTEM START-UP PROCEDURE

# 4.1 Solar Glycol System Fill

- 4.1.1 Fill the 55 gallon glycol fill tank with demineralized water and glycol (33 1/3% concentration).
- 4.1.2 Pump using P-8 pump, the glycol mixture into the solar glycol system. This must be performed during non-sunlight hours.
- 4.1.3 Repeat items 4.1.1 and 4.1.3 until approximately 508 gallons of solution or until the system is full.
- 4.1.4 Vent the solar panels at each end of the solar panels until fluid starts to come out the vent.
- 4.1.5 Start P-1 pump.
- 4.1.6 Vent excess air from the HX-2 heat exchanger.
- 4.1.7 Systematically close down each row of solar panels leaving at least one row full open until air bubbles noise stops in in the open row. Proceed to open each row separately until bubble noise stops.
- 4.1.8 Pressurize the system with glycol fluid until a pressure of 18-20 psig is reached.
- 4.1.9 The solar glycol compression tank CT-4 should be at the 50% fill mark.

# 4.2 Solar Hot Water System Fill

- 4.2.1 Fill the TES tank in the following manner:
- 4.2.1.1 Remove one of the temperature probes in the TES tank to permit venting of the tank while filling.
- 4.2.1.2 Attach domestic water supply to the hose bib on the solar hot water system at the HX-2 inlet
- 4.2.1.3 Position Valve RCV-2 in the A-AB position (stem in position)
- 4.2.1.4 Open valve V-44 (HX-2 inlet)
- **4.2.1.5** Close valve V-45 (HX-2 outlet)
- 4.2.1.6 Turn on domestic water supply until tank is full.
- 4.2.1.7 Shut off domestic water and disconnect
- 4.2.1.8 Re-install temperature probe in the TES tank.

RSPI

- 4.2.2 Fill the solar hot water system piping.
- 4.2.2.1 Verify that the SD-2 relay is in the winter mode.

Control	<u>Terminal</u>	<u>Voltage</u>	<u>Condition</u>
SD-1	24-31	24V	<b>O</b> pen
K-13		120V	<b>O</b> pen
SD-2	<b>25-3</b> 8	<b>24V</b>	Closed
K-11		120V	Closed
MS-3	14-6	1200	Start

- 4.2.2.2 Close valve V-61 (glycol pressurization valve) and V-62 (chilled water pressurization valve).
- 4.2.2.3 Open manual hot water valves (in attic) to heat pumps 1 thur 8.
- 4.2.2.4 Open the heat pump side panel (on roof) to one solar heat/cool coils.
- 4.2.2.5 Install shrader valve depresser tool on shrader valve vent.
- 4.2.2.6 Open heating remote control valves to the heat pump heat/ccol coils which have been vented.
- 4.2.2.7 Open domestic water valve to system pressurization valves.
- 4.2.2.8 Fill the solar hot water system with domestic water until water comes out the shrader valve vent.
- 4.2.2.9 During filling vent the system through the hose bibs available until all air is out.
- 4.2.2.10 Vent all heat pump heat/cool coils at shrader valve
- 4.2.2.11 Upon completion of filling the system close all hose bibs and shrader valve vents.

#### 4.3 Pre-start Up Check and System Pre-conditioning

- 4.3.1 Verify that the following valves are in the specified position.
- 4.3.2 The control system is completely automatic and requires no manual operation after the controls are set to the proper settings. Make the following adjustments prior to energizing the control system.
- Set TS-5 at 380F 4.3.2.1
- Set C-3A at  $180^{\circ}$ F 4.3.2.2
- Set C-3B at 120°F 4.3.2.3
- Set C-6C at 75°F 4.3.2.4
- 4.3.2.5

	38° F		
Verify	180°F		
Verify	160°F	MINIMOM	SEFFING
Verify	75°F		<del></del>
verify	125°F \$	20° Diff	

Item	Valve No.	Location	Required Position	Verify
1	<b>V-</b> 9A	East Pond Return	Closed	
2	<b>V-9</b> B	West Pond Return	<b>O</b> pen	~
3	V-10	P-5 Inlet	<b>O</b> pen	<u> </u>
4	V-77	P-5 Outlet	0pen	
5	V-12A	Filter A Inlet	Open	
6	V-12B	Filter B Inlet	<b>Open</b>	
7	V-12C	Filter C Inlet	<b>O</b> pen	_/
8	V-13A	Filter A Outlet	<b>O</b> pen	
9	V-13B	Filter B Outlet	<b>Open</b>	
10	V-13C	Filter C Outlet	0pen	
11	V-14	HX-3 By-Pass	0pen	
12`	V-15	HX-3 Inlet	Closed	_/
13	V-16	HX-3 Outlet	Closed	
14	V-17	HX-1 Inlet	0pen	
15	V-18	HX-1 Outlet	0pen	
16	<b>V-1</b> 9	P-7 Inlet	0pen	
17	V-20	P-7 Outlet	0pen	
18	V-21	East Pond Fill (Spray)	Closed	
19	V-22	East Pond Fill	Closed	
20	V-23	West Pond (Spray)	Open ,	
21	V-24	West Pond Fill	0pen	
22	V-25	East Pond Doughboy Inlet	Closed	
23	V-25A	East Pond Inlet Bypass/Cutoff	Closed	_/_
24	V-26	East Pond Outlet Bypass	Closed	
25	V-27	East Pond Doughboy Outlet	Closed	
26	V-28	West Pond Doughboy Inlet	Closed	
27	V-29	West Pond Doughboy Outlet	Closed	
28	V-30	P-1 Inlet	0pen	
29	V-31	P-1 Outlet	0pen	1
30	V-32	Cutoff Valve to Roof	0pen	
PC - Poi	lar Glycol Sys nd Cooling Sys lar Hot Water S	tem DW - Domestic Water Syste		RSP

<u>Item</u>	Valve No.	Location	Required Position	Verify
31	V-33	HX-2/HX-1 By-pass	Closed	
32	V-34	HX-1 Inlet	<b>O</b> pen	
33	V-35	HX-1 Outlet	0pen	
34	V-36	HX-2 Inlet	0pen	
35	V-37	HX-2 Outlet	0pen	/_
36	<b>V-4</b> 0	AS-2 Inlet	0pen	
37	V-41	AS-2 Outlet	0pen	_/_
38	V-42	P-2 Inlet	<b>O</b> pen	
39	V-43	P-2 Outlet	0pen	
40	V-44	HX-2 Inlet	0pen	
41	V-45	HX-2 Outlet	0pen	
42	V-46	P-3 Inlet	0pen	
43	V-47	P-3 Outlet	0pen	
44	V-48	HX-3 Inlet	0pen	
45	V-49	HX-3 Outlet/P-6 Inlet	0pen	
46	V-50	P-6 Outlet	0pen	<u> </u>
47	V-51	AS-3 Inlet	Closed	
48	V-52	P-4 Inlet	Closed	
49	V-53	P-4 Outlet	Closed	_/
50	V-54	ARKLA Inlet	Closed	
51	V-55	ARKLA Outlet	Closed	
52	V-60A	Pond Fill Water-Pond # East	Closed	. <u>/</u>
53	V-60B	Pond Fill Water-Pond # West	Closed	_/
54	V-61	Glycol System Pressurization	Closed	
55	V-62	Chilled Water Pressurization	Closed	
56	RCV-1		B-AB (Stem Out)	
<b>57</b>	RCV-2		B-AB (Stem Out)	_/_
58	RCV-3		By-pass	
59	RCV-4		B-AB (Stem Out)	_/
60	RCV-5		AB-A (Stem In)	
61	RCV-8			RAG

# 4.4 Startup

The control system is completely automatic and requires no manual operation except the following:

4.4.1 Switch circuit breaker No. 1 "Arkla" to the <u>OFF</u> position.

Verify

4.4.2 Switch circuit breaker
"Control" No. 3 to the <u>ON</u> position

Verify

4.4.3 Switch circuit breaker
"Heat pump control" No. 5 to the <u>ON</u> position.

Verify

4.4.4 Switch circuit breaker
"P6-P8" No. 7 to the <u>ON</u> position.

Verify

4.4.5 Switch circuit breaker
"Sump Pump" No. 9 to the ON position.

Verify

4.4.6 Switch circuit breaker "RCV" to the <u>ON</u> position.

Verify

# 4.5

# SOLAR COLLECTOR CIRCUIT SETTER PROCEDURE FOR POSITIONING.

- 1. Install a readout probe No. RP-250B in each differential pressure meter hose coupling.
- 2. Place differential pressure meter on its back with meter face horizontal.
- 3. Close all 3 valves on meter.
- 4. Check the zero (wide open) setting of the circuit setter. See pages 14 and 15 of Bell & Gossett "Circuit Setter Valve Balance Procedure Manual" HS-CS-671. Adjust zero pin if necessary.
- 5. On differential pressure meter close all three valves.
- 6. Attach meter hoses (with readout probes) to circuit setter pressure tap points. Connect red hose to inlet side of valve and green hose to outlet side. Tighten probe slip nut onto tap point hand tight or to stop leaks.
- 7. Open "Balance" (black handle) valve.
- 8. Crack both "Bleed High" and "Bleed Low" valves until all air has been expelled out the clear plastic tubing, from the instrument and hoses.
- 9. Close all valves and read the differential pressure on the meter with the circuit setter wide open (zero position).
- 10. On the circuit setter calculator side 2 top scale (red half) set hairline over 0 on the 3/4" valve size scale. (Note All collector circuit setters are 3/4"). On the bottom scale read GPM flow opposite head loss in ft. of H<sub>2</sub>O as found in Step 9 above.
- 11. In Paragraph 14 below, find the design flow rate for the particular collector row being checked.
- 12. The actual flow rate found in Step 9 above will probably be greater than the design flow rate. If so, estimate the proper valve position and repeat Steps 9 and 10. Repeat this procedure until the correct actual flow rate is secured.  $_{\rm R-12}$

- 13. Record the results on the attached form "Solar Collector Circuit Setters". File a copy in the Project Sunburst file in Richland Mechanical and send two copies to Seattle Mechanical.
- 14. Flow rates thru collector rows:

ROWS	NO. OF COLLECTORS	FLOW RATE GPM.
W-c, W-d, W-e, W-f	8	. 4.0
W-b, W-g, W-h, W-i, W-j E-f, E-g, E-h, E-i, E-j	9	4.5
W-k, W-l E-a, E-e, E-m	10	5.0
W-a, W-m E-k, E-l	11	5.5
E-b, E-c, E-d	12	6.0



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OLYMPIC ENGINEERING CORPORATION 3070 GEORGE WASHINGTON WAY RICHLAND, WASHINGTON 99352

PROJECT SUNBURST

SOLAR COOLING
START-UP PROCEDURE

and
FUNCTIONAL ACCEPTANCE TEST

Prepared by 1

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# 1.0 SCOPE

The solar cooling start-up procedure covers the initial installed checkout of the Solaire 300, 25 ton absorption chiller model No. WFB-300 and the associated checkout of the chilled water system. All adjustments and remedial action which may result from this procedure are to be made by the Arkla-Solaire field representative or upon direction from Arkla-Solaire.

# 2.0 APPLICABLE DOCUMENT

# 2.1 Drawings

- 2.1.1 7608-M-3 Rev 5 Basement and Attic Section amd Miscellaneous
- 2.1.2 7608-M-4 Rev 8 First Floor Plan Ponds
- 2.1.3 7608-M-5 Rev 4 Attic Plat
- 2.1.4 7608-M-6 Rev 7 Roof Plan
- 2.1.5 7608-M-7 Rev 7 TES Tank
- 2.1.6 7608-M-10 Rev 5 Miscellaneous Details (Schedules)
- 2.1.7 7608-M-11 Rev 4 Underground Piping
- 2.1.8 7608-M-12 Rev 3 Schematic Flow Diagram
- 2.1.9 7608-M-16 Rev O Solar Basement Plans and Miscellaneous
- 2.1.10 6039 E-3-1 Rev O Basement Power Pwr Misc Circuits
- 2.1.11 6039 E-3-2 Rev 2 Basement Power Control Circuit
- 2.1.12 6039 E-3-3 Rev O Basement Power Wiring Diagram
- 2.1.13 6039 E-3-4 Rev O Basement Power Panel G. Connection

# 2.2 Specifications

2.2.1 Project Sunburst solar demonstration specification for mechanical work dated 12 October 1976.

# 2.3 Manuals

- 2.3.1 Document No. OMM-1 January 1977 Solar System Operation and Maintenance Manual.
- 2.3.2 SD Document No. 76SDS4281 January 1977 Solar Heating and Cooling System Design.
- 2.3.3 Model No. WFB Installation and Start-Up Data Solaire 300 25 Ton Absorption Chiller for Solar Air Conditioning Updated February 1977 P/N 14084-609.

# 3.0 REQUIREMENTS

#### 3.1 Controls

3.1.1 Chilled Water Low Temperature Safety Switch
(Arkla Part No. 14537-298) (Ranco Part No. A22-2265)

The purpose of this switch is to interrupt cooling pond operation and allow the hot water valve to close in case the chilled water temperature drops to approximately  $39^{\circ}F$ . It will automatically reset when the chilled water temperature rises to approximately  $46^{\circ}F$ .

3.1.2 Evaporator Low Temperature Safety Switch
(Arkla Part No. 14537-297) (Ranco Part No. A22-2267)

The purpose of the switch is to interrupt cooling pond operation and allow the hot water valve to close if the coil temperature goes down to approximately  $33^{\circ}F$ . The switch will automatically reset when the coil temperature rises approximately  $6^{\circ}F$ .

# 3.1.3 Condensing Water Switch

The purpose of this switch is to energize the refrigerant dump valve if the entering condensing water temperature drops to 77°F and will de-energize the refrigerant dump valve when the condensing water temperature rises to 80°F.

3.1.4 Condenser High Temperature Switch
(Arkla Part No. 14327-296) (Ranco Part No. A22-2266)

The switch breaks at 115°F and re-makes at 100°F. It is wired to shut off the hot water valve only when it breaks at 115°F.

3.1.5 Flow Switch
(Arkla Part No. 14537-160) (Mc Donald and Miller Part No. FS4-3A)

The purpose of this control is to interrupt unit operation if chilled water flow should drop below recommended GPM. If this control is improperly adjusted and the unit is permitted to operate at too low a chilled water flow, damage from freezing can occur. B-17

Note: The microswitch (Arkla part No. 14537-169) should be replaced annually. See Service Bulletin No. 91, dated 9-24-65.

# 3.1.6 Condensing Water temperature Control (RCV-8 Control C-6C)

The inlet condensing water to these units must be maintained at approximately 75°F or above. The adjustment of the condensing water blending valve should be checked on every new start-up and every spring start-up. The temperature check should be made at the factory installed thermometer well - inlet condensing water to absorber.

# 3.2 Level

Leveling is considered one of the major adjustments on the unit. The unit should have been leveled at the time that it was placed in position, but it must be checked again to MAKE SURE THE UNIT IS LEVEL.

# 3.3 Chilled Water

#### 3.3.1 Chilled Water Flow Rate

The maximum chilled water flow rate is 100 GPM. (100 GPM = 10.7 psi. Press drop across the chilled water in and out press taps.)

The minimum chilled water flow rate is 30 GPM. (30 GPM = 1.2 psi press drop). Record press drop number stamped on unit frame nearest chilled water lines. Press Drop 3.7 psi @ 60 GPM.

**V**erify

# CHILLED WATER

# FLOW TABLE

GPM 35 40 45 50 55 60 65 70 75 80 85 90 95 100 PRESS DROP 1.2 1.5 2.0 2.5 3.1 3.7 4.3 5.1 5.9 6.8 7.8 8.7 9.8 10.7 (psi)

Table 1.

# 3.4 Condensing Water

#### 3.4.1 Condensing Water Flow Rate

It is important that the condensing water flow of 90 GPM be adjusted correctly. A unit operating at rated 25 ton must have 90 GPM condensing water flow. The maximum condensing water flow rate is 110 GPM. @ 90 GPM.

Record press drop number stamped on unit frame nearest condensing water lines inlet and outlet.

Press Drop 8.0 psi @ 90 GPM.

Verify

# CONDENSING WATER

#### FLOW TABLE

#### 3.5 Hot Water (Generator) Water

#### 3.5.1 Hot Water For Generator Flow Rate

A unit operating at rated 25 ton must have 90 GPM hot water flow. The maximum hot water flow rate is 100 GPM.

Stamped on the unit frame is a number that represents the actual pressure drop (psi) for this particular unit at 90 GPM water low. This number must be used to correctly adjust to the proper pressure drop and flow rate for the particular designed operation.

Record pressure drop number stamped on unit frame near the hot water (generator) inlet and outlet and below the stamped number for the condensing water flow.

Press Drop 1.5 psi @ 90 GPM.

\_\_\_\_\_\_ Verify

# HOT WATER (GENERATOR) FLOW TABLE

GPM 40 45 50 55 60 65 70 75 80 85 90 95 100 PRESS DROP .28 .30 .40 .50 .61 .72 .84 1.02 1.15 1.35 1.50 1.70 1.90 (psi)

3.5.2 Hot Water Valve

#### 3.5.2.1

The hot water valve modulation controls the chilled water outlet temperature. When the chilled water flow rate reaches 30 GPM or greater the hot water valve is energized. The valve begins to open which then operates a switch at 15% open position. This switch action de-energizes the thermal delay relay heater. The hot water valve will go to the full open position if the leaving and entering chilled water temperature is above  $44^{\circ}$  to  $54^{\circ}$ F. When the leaving chilled water temperature drops below  $45^{\circ}$ F the hot water valve will operate in a partial bypass position. When the leaving chilled water temperature drops below  $40^{\circ}$ F, the hot water valve will move to the 85% bypass position and actuate a switch initiating the thermal delay relay heater.

# 3.6 Solution Pump

# 3.6.1 Solution Pump Operation

The solution pump is belt driven by a 1/4 HP motor.

Pump shaft rotation <u>must be counter clockwise at all times to prevent</u> internal damage to the solution pump. Pully alignment is very important in preventing unnecessary belt wear. Solution pump shaft should turn approximately 800 to 900 RPM.

# 4.0 START-UP PROCEDURE

# 4.1 Pre-Start-up Control Check

4.1.1 Chilled Water Low Temperature Safety Switch

To check the calibration of this switch, turn the "ON-OFF" switch to the "OFF" position and remove bulb from well. Place bulb and a thermometer in a container with enough water in it to completely immerse the bulb. Add ice and stir constantly with thermometer. Listen closely at switch for audible "click" when water temperature is lowered to 39°F. Warm the water in the container, the audible click should be heard again when the water temperature rises about 7°F.

Verify

This switch can be adjusted in the field, BUT EXTREME CARE SHOULD BE TAKEN TO ADJUST IT ACCURATELY. The calibration should be checked several times before making change. To adjust, remove the phenolic end cover from the switch. A screw driver adjustment will be noted as well as an indicating arrow for raising or lowering control point. Check for correct calibration several times after making any change in adjustment. Be sure well is full of glycerine before replacing bulb.

Note: DO NOT OPERATE UNIT WITH SWITCH ELECTRICALLY JUMPERED.

# 4.1.2 Evaporator Low Temperature Safety Switch

To check the calibration of this switch, turn the "ON-OFF" switch to the "OFF" position and remove bulb from well. Place bulb and a thermometer in a container with enough water in it to completely immerse the bulb. Add ice and stir constantly with thermometer. Listen closely at switch for audible "click" when water temperature is lowered to 33°F. Warm the water in the container, the audible click should be heard again when the water temperature rises about 6°F.

Note: UNDER NO CIRCUMSTANCES OPERATE THE UNIT WITH THIS SWITCH ELECTRICALLY JUMPERED.

Verify

# 4.1.3 Condensing Water Switch

To check the calibration of the condensing water switch. turn the "ON-OFF" switch to the "OFF" position and remove the bulb from its well. Place bulb and a thermometer in a container with enough water in it to completely immerse the bulb. Add ice (or cooler water) and constantly stir with the thermometer. Listen closely at switch for an audible click when water temperature is lowered to 77°F.

Verify

Note: IF A SWITCH IS DEFECTIVE, REPLACE IT. UNDER NO CIRCUMSTANCES OPERATE THE UNIT WITH A CONDENSING WATER SWITCH ELECTRICALLY JUMPERED.

# 4.1.4 Condenser High Temperature Switch

To check calibration of this switch turn "ON-OFF" switch to the "OFF" position and remove bulb from its well. Place bulb and a thermometer in a container with enough tap water in it to completely immerse the bulb. Heat the water slowly constantly stirring with the thermometer. Listen closely at switch for an audible click when the temperature of the water reaches 1150F. Cool the water slowly in the container and listen for the same audible click when the water temperature reaches  $100^{\circ}$ F.

Verify

Note: IF THIS SWITCH IS DEFECTIVE, REPLACE IT. UNDER NO CIRCUMSTANCES OPERATE THE UNIT WITH THIS SWITCH ELECTRICALLY JUMPERED.

#### 4.1.5 Flow Switch

Check at start-up of the unit in the following manner:

a. Turn off the unit's main switch and connect a continuity test light across terminals 1 and 2 of the flow switch being tested after removing cover to the switch. MAIN SWITCH OFF UNTIL TEST IS COMPLETED.

Verify

b.	Manually start the chilled water circulating pump (P-4 and establish full circulation. Continuity light should come on as soon as water begins circulating through unit evaporator coil.	Verify
<b>c.</b>	Manually throttle chilled water flow with the throt- tle valve to just at the point where continuity light goes out indicating the flow switch has "cut off".	Verify
<b>d.</b>	With water flow throttled as above in step C, measure pressure drop across chilled water headers.  Pressure drop should correspond to a flow of NOT LESS THAN 30 GPM to open switch nor more than 35 GPM to close switch.	
e.	If necessary, adjust cut-off point of the flow switch to bring it within the proper range. To adjust, reduce chilled water flow until pressure drop indicates the recommended GPM to open switch.  Turn adjusting screw clockwise to raise cut-off	N A

Note: ADJUST CUT-OFF POINT ONLY. UNDER NO CIRCUMSTANCES SHOULD AN ATTEMPT BE MADE TO CHANGE DIFFERENTIAL SETTING OF FLOW SWITCH.

DO NOT OPERATE THE UNIT WITH A DEFECTIVE FLOW SWITCH OR WITH THE MICROSWITCH ELECTRICALLY JUMPERED.

point or counter clockwise to lower cut-off point.

4.1.6 Condensing Water Temperature Control (RCV-8 Control C-6C)

A temperature check is to be made at the Arkla Condensing water inlet tap thermometer well.

# Verify

Verify

#### 4.2 Level

Location of a slot to be used for a plumb bob line has been provided. A good plumb bob, non-magnetic, with a "L4F" fly line to fit into the point of this slot, should be used. Put the line into the slot and lower the plumb bob until its point

is almost in the hole of the special plate directly below the slot on the unit frame. The unit is level when the point of the plumb bob is in the exact center of the hole in the plate.	
Note: DO NOT ENLARGE STRING SLOT	Verify
Adjust levelizing bolts until unit is level. Threaded part of bolt should not protrude more than 1" below bottom of frame. Insert shims under bolt, if necessary, to eliminate long bolt protrusion.	
Once the unit is level, steel shims should be used to support the units weight.	
4.3 Chilled Water System Check	
4.3.1 Chilled Water Flow Rate	
Determine the flow rate of the chilled water system at the maximum flow rate using table in paragraph 3.3.1.	
Press Drop	
	<u>V</u>
Flow Rate 96.1 GPM	Verify
Flow Rate 96.1 GPM 4.3.1.1	Verify
	Verify
4.3.1.1	Verify
4.3.1.1 Reset chilled water flow rate to the following:	Verify Verify
4.3.1.1  Reset chilled water flow rate to the following:  Pressure Drop 8.7 psi	
4.3.1.1  Reset chilled water flow rate to the following:  Pressure Drop 8.7 psi  Flow Rate 90 GPM	
4.3.1.1  Reset chilled water flow rate to the following:  Pressure Drop 8.7 psi  Flow Rate 90 GPM  4.4 Condensing Water System Checkout	
4.3.1.1  Reset chilled water flow rate to the following:  Pressure Drop 8.7 psi  Flow Rate 90 GPM  4.4 Condensing Water System Checkout  4.4.1 Condensing Water Flow Rate	
4.3.1.1  Reset chilled water flow rate to the following:  Pressure Drop 8.7 psi  Flow Rate 90 GPM  4.4 Condensing Water System Checkout  4.4.1 Condensing Water Flow Rate  The flow rate data is as shown in Table 2, paragraph 3.4.1.  While checking and adjusting the condensing water flow rate,	
A.3.1.1  Reset chilled water flow rate to the following:  Pressure Drop 8.7 psi  Flow Rate 90 GPM  4.4 Condensing Water System Checkout  4.4.1 Condensing Water Flow Rate  The flow rate data is as shown in Table 2, paragraph 3.4.1.  While checking and adjusting the condensing water flow rate, the Solaire unit itself should be turned off.	
A.3.1.1  Reset chilled water flow rate to the following:  Pressure Drop 8.7 psi  Flow Rate 90 GPM  4.4 Condensing Water System Checkout  4.4.1 Condensing Water Flow Rate  The flow rate data is as shown in Table 2, paragraph 3.4.1.  While checking and adjusting the condensing water flow rate, the Solaire unit itself should be turned off.  1. Turn "ON-OFF" switch on side of unit control panel	Verify

3.	Open all valves in the condensing water piping. Make sure the cooling ponds are full of water.	✓ Verify
4.	Attach a gauge to the pet cocks on the condensing water circuit.	✓ Verify
5.	The proper flow rate for the system is shown on Table 2.	
6.	Operate the condensing water circulating pump (P-5) only for at least five minutes. Turn off condensing water pump. Clean the cooling pond screens and filters in the condensing water lines. Turn on condensing water pump. (P-5)	Verify
7.	Open both the pet cocks to fill the hoses and gauge with water. Bleed each line from air.  When the pressure is steady, read and record the pressure. Read the differential on the Barton	Verify

Item No.	Measurement	Press	Units	
1	Inlet Pressure	NA	PSIG	
2	Outlet Pressure	NA	PSIG	
3.	Differential Pressure (Calculated)	9.1	PSI	
	(Item 1 - Item 2 = $\Delta P$		Verif	<b>y</b> Boron Carantago (1971)
8.	setting the filter outlet valves	to achieve a		
	differential pressure across the 8.0 psi.	condenser of		
Record	Actual AP 8.0 PSI		<u>/</u>	
Flow Ra	ite 90 GPM		Verify	

differential pressure gage.

9. Once the desired flow rate has been set, the position of the filter outlet valve should be permanently marked Verify for future reference.

# 4.5 Hot Water (Generator) Water Flow Rate

- 4.5.1 Hot Water for Generator Flow Rate
- 1. Attach a gauge to the pet cocks on the generator hot water circuit.

Verify

- 2. The proper flow rate versus pressure drop for the system is shown on Table 3.
- 3. Operate the hot water (generator) circuit system pumps P-2 and P-3 at least 5 minutes prior to pressure readings.

Verify

4. Open both the pet cocks to fill the hoses and Barton gauge with water. Bleed each line from air. Close the pet cock on the outlet line. When the pressure is steady, read and record the pressure.

Verify

Item No.	Measurement	Press	Units
1.	Inlet Pressure	NA	PSIG
2.	Outlet Pressure	NA	PSIG
3.	Differential Pressure (Calculated)	1.44	PSI
	(!tem   -   Item   2 = ΔP	en e	<u>√</u> Verif∨

5. Set the predetermine flow rate of 90 GPM by setting the hot water (generator) circuit setter to achieve a differential pressure across the generator of 1.5 psi.

	/ Rate	e <u>88</u> GPM Setter Position <i>© PEN</i>	Verify
••••			· · · · · · · · · · · · · · · · · · ·
		.2 Modulation of Hot Water Valve Check	And the second s
On i		al start-up check the modulation of the hot water valve.  Make certain the main electrical switch on the side of	
	1	the control box is the "OFF" position.	Verify
	2.	Connect V-O-M leads to OPI (+) and common (-). Lead	
•	-•	from positive (+) on meter must be connected to OPI (+).	Verify
		Refer to sketch Number 1. Set VOM setting on 60 volts DC.	
	3.	Move the main electrical switch on the side of the control	<u>/</u>
		box to the "ON" position.	Verify
	4.	If there is no voltage reading on the meter, check the	•
		power supply and for loose connections.	
	5.	A voltage of 9 to 10 V.D.C. is required to operate the	
		<pre>valve and cause the valve indicator to move from the "CLOSED" to the full "OPEN" position.</pre>	
	6.	Allow sufficient time (2 minutes) for the hot water valve to move to the full "OPEN" position.	
	7.	Put thermometers in the thermometer wells in the inlet	
		and outlet chilled water lines.	
	8.	Reduce the chilled water flow through the air handlers	Verify
		by slowly closing the gate valve on the chilled water inlet to the ARKLA.	
	9.	Watch the thermometers and the VOM. When the inlet	
	<b></b>	chilled water temperature goes down to about 52°F or	Verify
		the outlet chilled water goes down to about 42°F, the	
		voltage should drop slightly and the valve should	
		start to modulate.	
	10.	Immediately open the valves for the chilled water flow	Verify
		thru the air handlers.	

	(Re	#9, perform the following checks in order: ference ARKLA Solaire Installation and Start-up a Manual P/N 14084-609.)	
	a.	Check both chilled water sensors for an open circuit	it.
	b.	Check 2-Input Controller calibration.	
12.		e sufficient voltage reading, but hot water valve s not operate, perform the following checks in order	<i>N</i> <b>A</b>
	<b>a.</b>	Check both chilled water sensors for a shorted circuit.	
	b.	Check for a defective valve actuator.	
4.6 <u>Sc</u>	olutio	n Pump Operation	
4.	6.1		/
Verify	that	the pully alignment is correct.	Verify
4.	6.2		V 1
Verify	that	the pully belt tension is correct.	Verify
4.	.6.3		NA
Measure	e the	Solution Pump shaft speed and record.	Verify
		Shaft Speed NA RPM	
4	.6.4		

11. If the hot water valve does not modulate as described

RSS

Verify that the pump shaft rotates counter clockwise.

# APPENDIX C

PROJECT SUNBURST DESIGN DRAWINGS

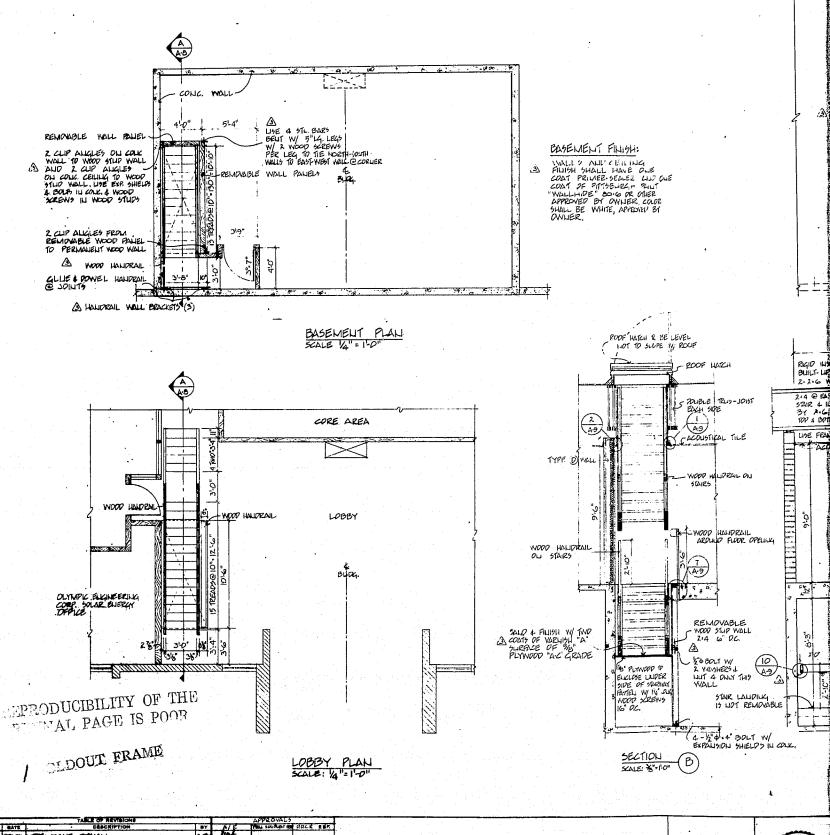
# APPENDIX C DESIGN DRAWINGS

# INTRODUCTION

The following is a list of the Hanford Square Building #2 Drawings pertinent to the solar demonstration system. This list of drawings will serve as an index to the reduced drawings included in this appendix.

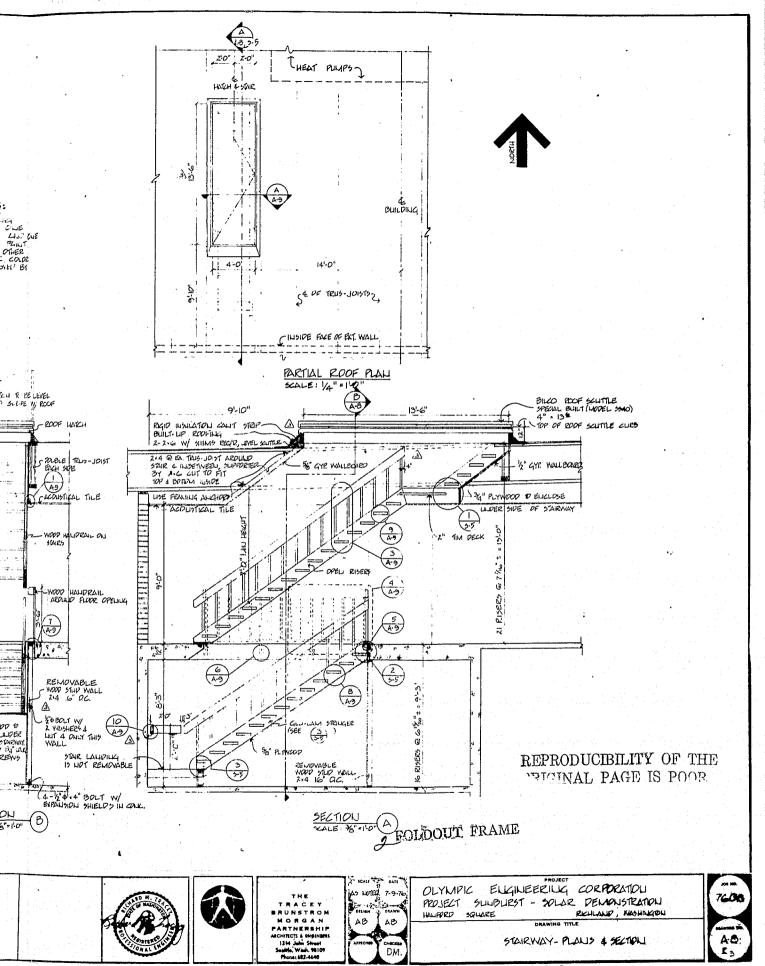
Drawing No.	Rev. No.	Rev. Date	Drawing Title
A-8	3	11/11/76	Stairway, Plans & Section
A-9	3	11/11/76	Stairway, Details
A-10	4	12/02/76	Collector Layout
A-11	6	12/13/76	Room Layout, Building #2
E-3-1	0	12/02/76	Schematic Diagrams Power Circuits
E-3-2	2	04/19/77	Schematic Diagrams Control Circuits
E-3-3	1	03/18/77	Motor Starter Panels Wiring Diagrams
E-3-4	2	04/19/77	Schematic Diagrams, Panel "G" External Connections
E-3-5	9 1 2 1 <b>0</b> 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	04/14/77	Schematic Diagrams, HVAC Interstage Controls
E-3-6	<b>A</b>	04/12/77	Relay Panels HVAC Interstage Controls
E-4-1	<b>3</b> .	04/19/77	Electrical Control System Basement Power and Controls
E-4-2	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	12/02/76	Equipment & Conduit Layouts Motor Starter Panel
E-4-3	2	01/04/77	Equipment & Conduit Layouts Power Distribution Center
E-4-4	0	04/14/77	Interconnections HVAC Interstage Controls
M-3	5	04/05/77	Basement & Attic Plans
M-4	8	01/07/77	First Floor Plan, Ponds
M-5	4	04/05/77	Attic Plan
M-6	7	04/05/77	Roof Plan
M-7	7	01/07/77	TES Tank & Miscellaneous Detail
M-10	5	04/05/77	Miscellaneous Details, Schedules
M-11	4	01/07/77	Underground Piping
M-12	3	04/05/77	Schematic Flow Diagram
M-14	0	12/27/76	Underground Piping

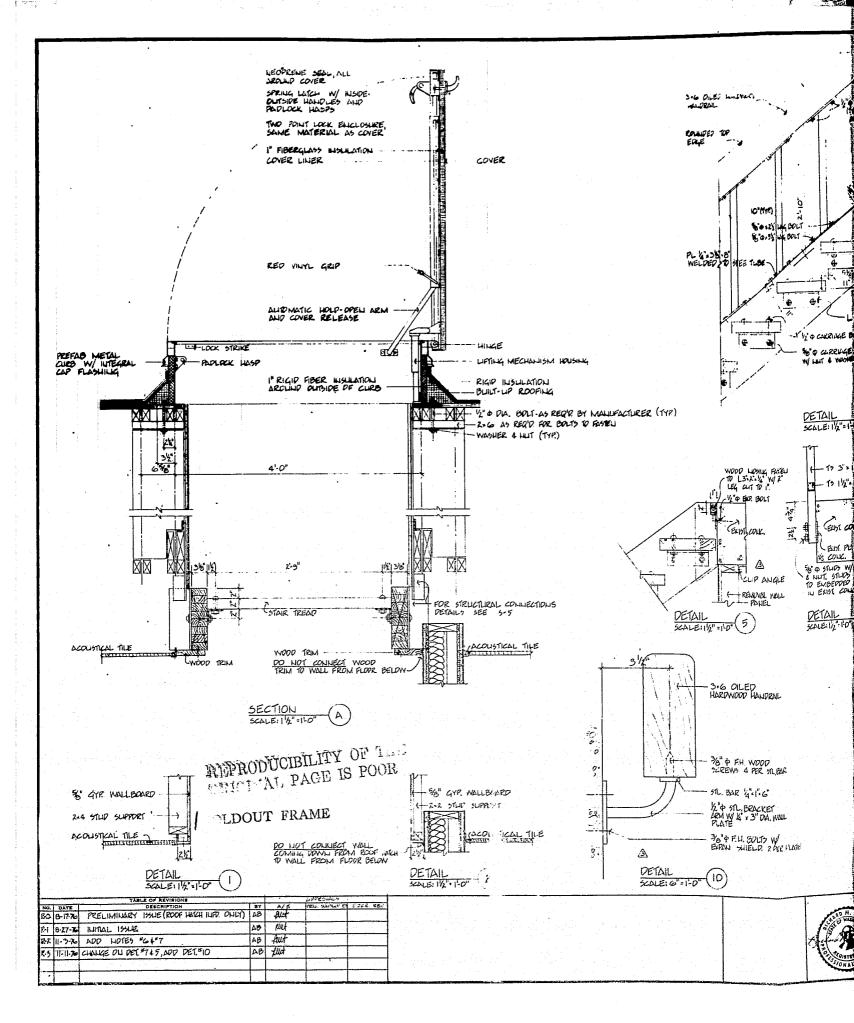
Drawing No.	Rev. No.	Rev. Date	Drawing Title
M-15	0	12/27/76	Solar Piping In Attic
M-16	0	04/05/77	Solar Basement Piping
S-3	2	06/22/76	Floor, Basement, & Foundations Plan
S-4	2	08/16/76	Roof Framing Plan & Details
S <b>-</b> 5	4	09/15/76	Stair & Solar Collector Tie-Down
S <b>-</b> 8	2	09/21/76	Reflecting Pond Detail
101 (Shts. 1, 2,&3)	0	03/08/77	Lengths, Hole, & Burnout Locations in 3" X 3" Tubing
102 (Shts. 1 & 2)	0	03/08/77	Custom Drilling Beam Mounting Bolt Hole Locations
103	0	03/08/77	Location and Installation of Collector Beams
104 (Shts 1 & 2)	0	03/08/77	3" X 3" Tubing Layout for Center Sections
105	0	12/07/76	Detail Drawing of Struts for Collector Mounting
106	0	03/08/77	Locations of Various Strut & Collector Types
107	0	03/08/77	Collector & Strut Mounting

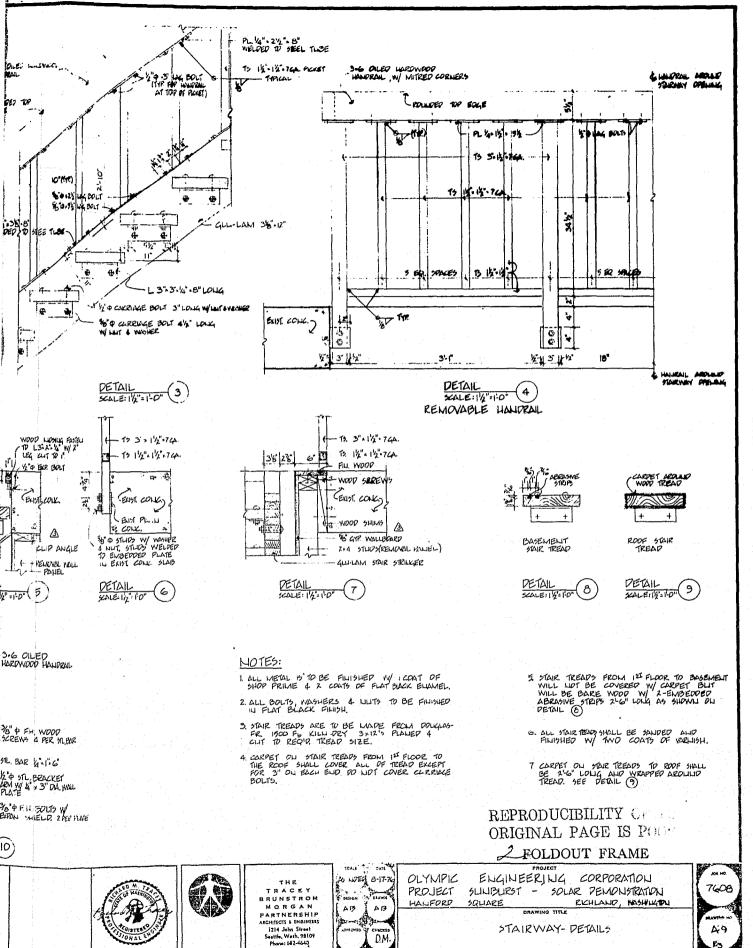


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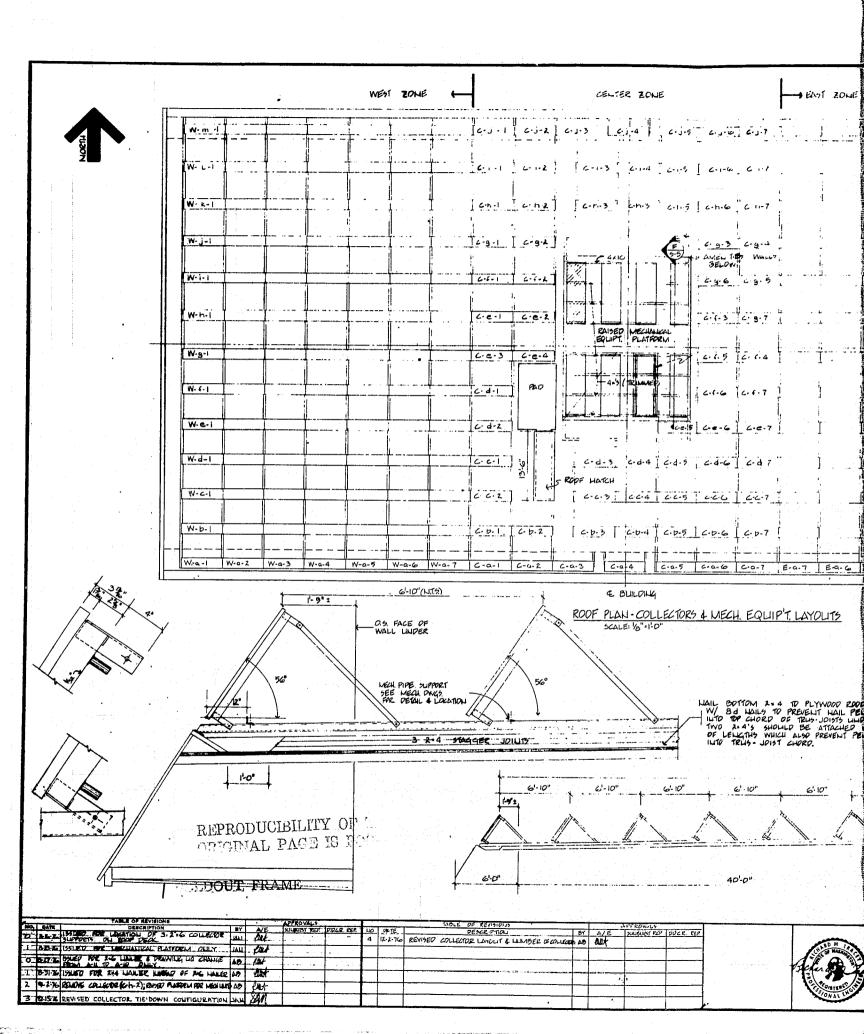


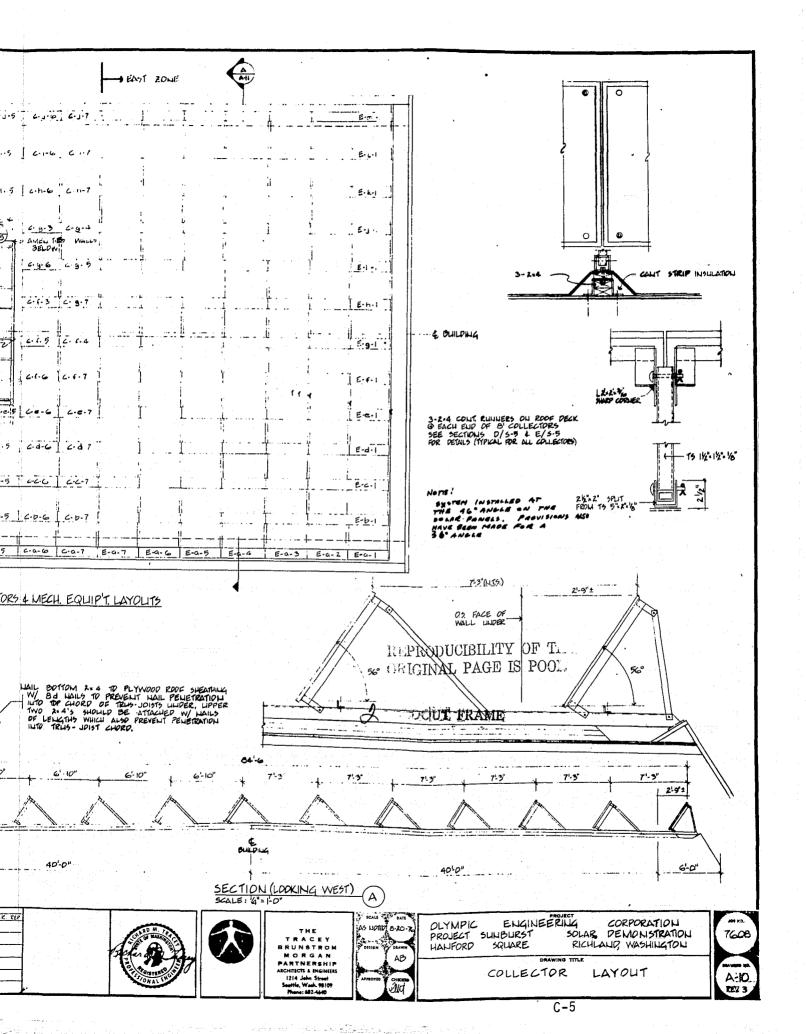


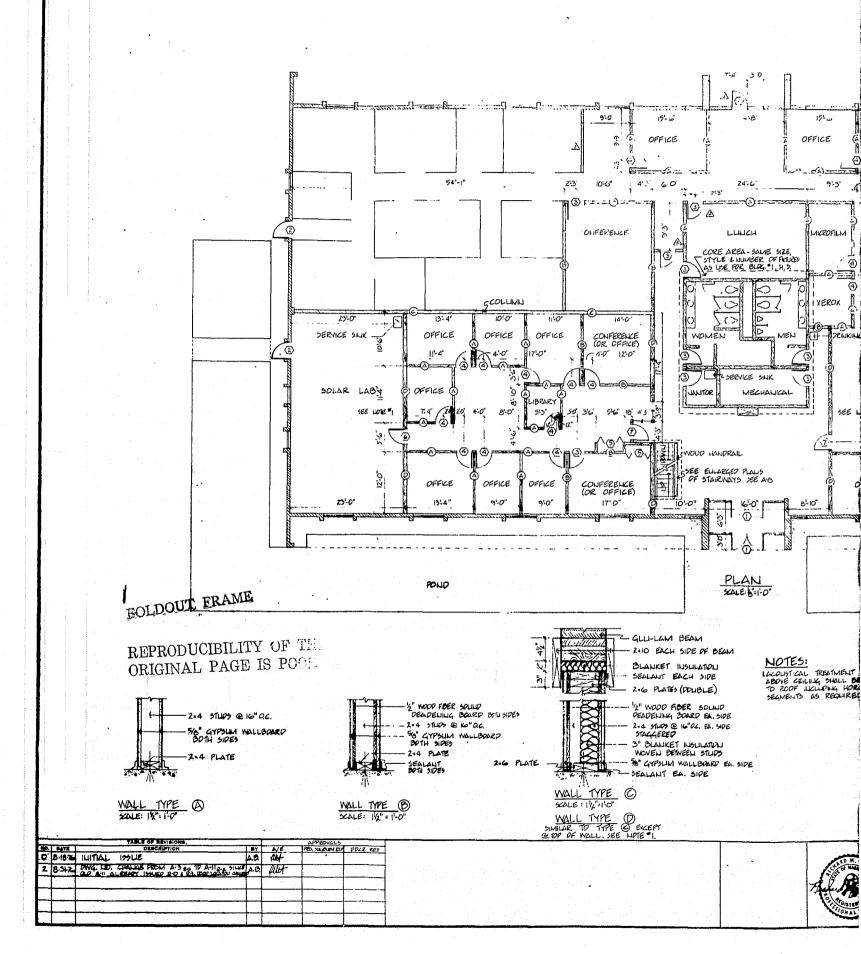




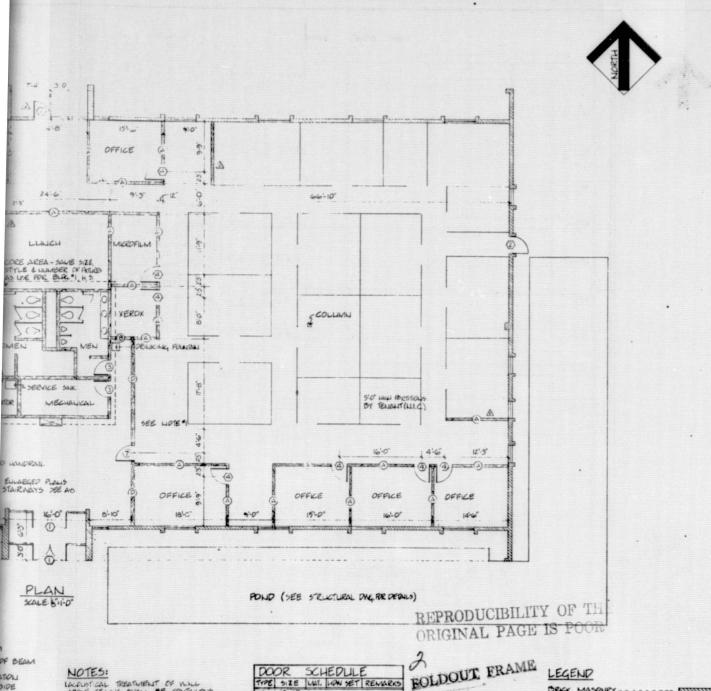
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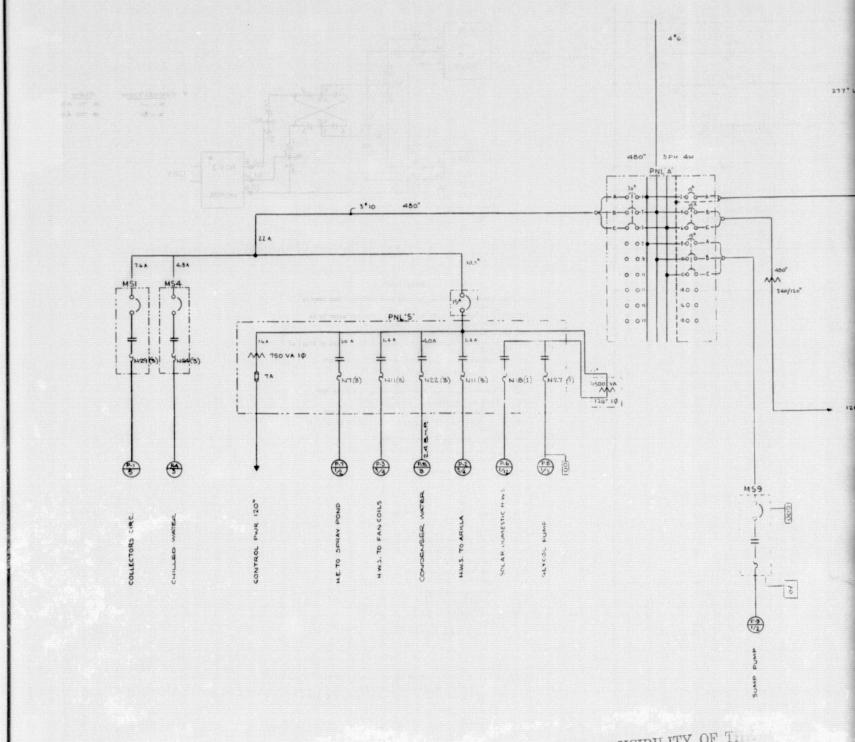


OLYMPIC ENGINEERING CORPORATION
PROJECT SUMBLIRST SCHAR DEMONSTRATION
HANFORD SQUARE REHIGHD, WASHINGTON

DRAWING TITLE

ROOM LAYOUT BLOG. #2

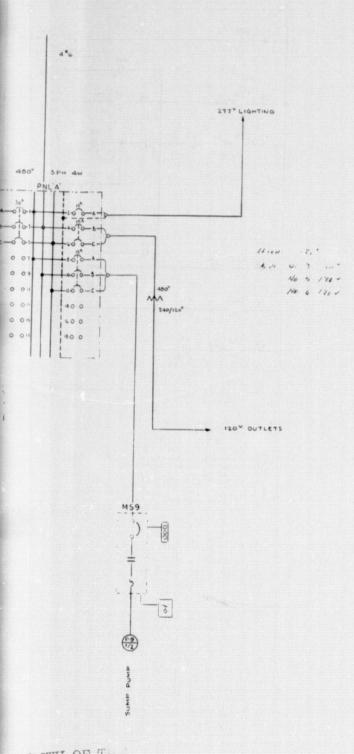




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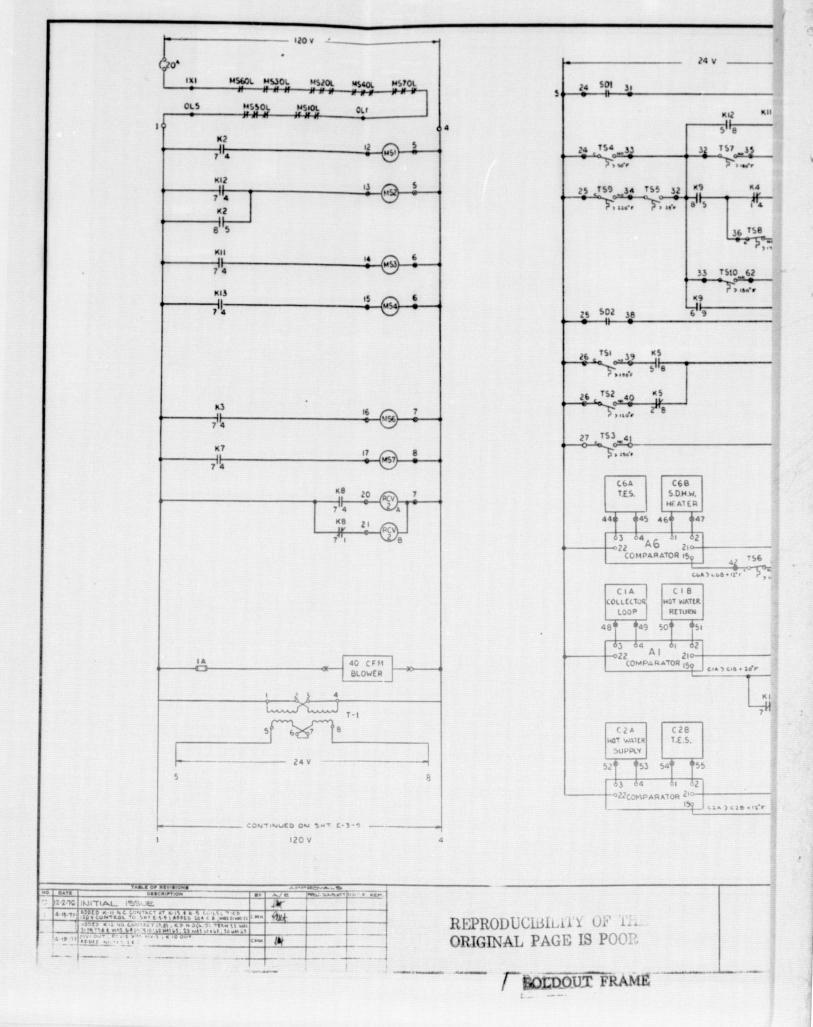


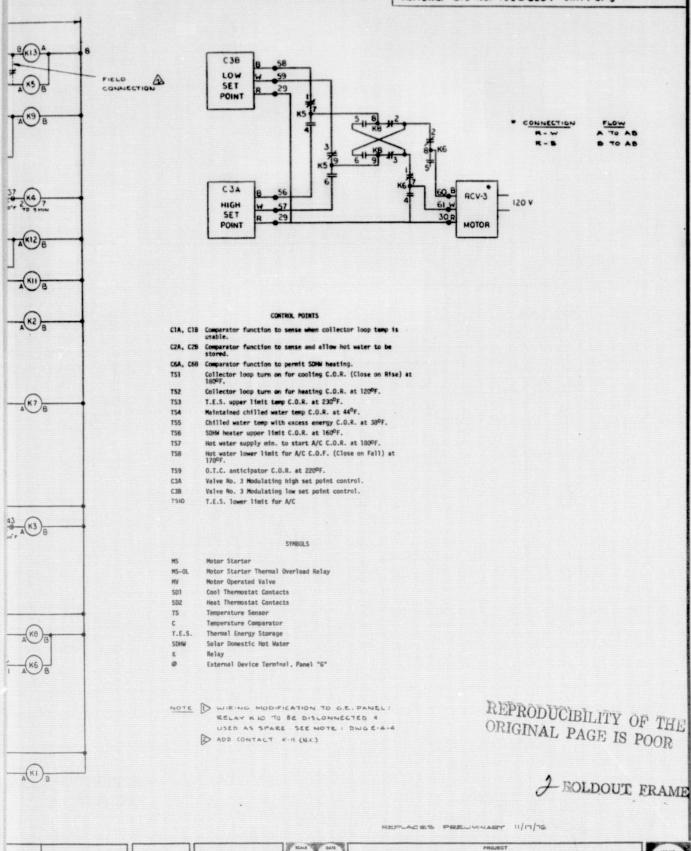


PROJECT SUNBURST - SOLAR DEMONSTRATION
HANFORD SQUARE RICHLAND , WASHINGTON

BASEMENT POWER & CONTROLS - BLDG NO.2
SCHEMATIC DIAGRAMS
POWER CIRCUITS





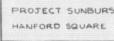






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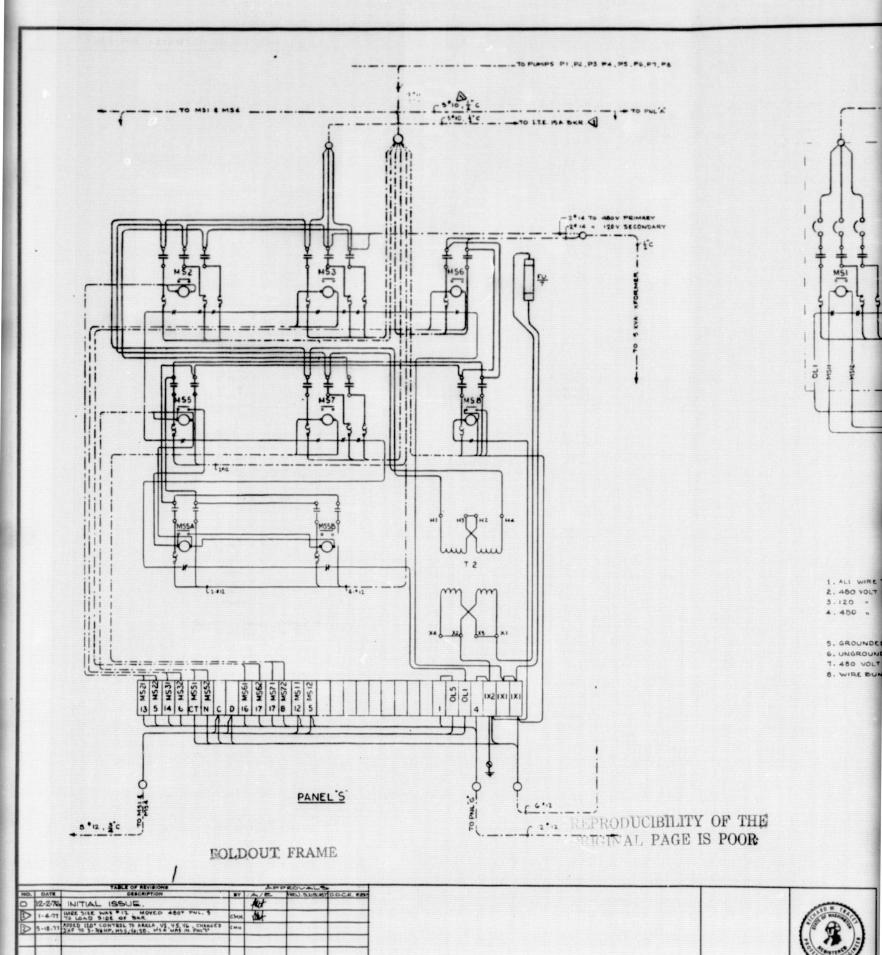
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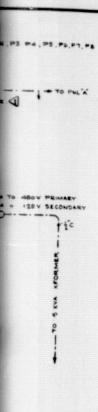


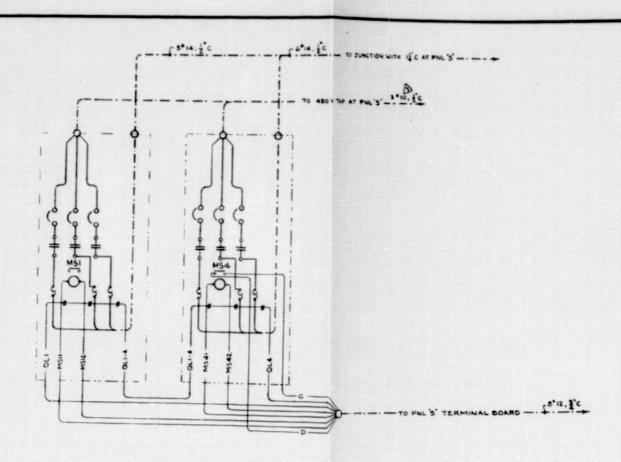
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SEMINT POWER & CONTROLS - BLDG. NO 2 HENIATIC DIAGRAMS CONTROL CIRCUITS







### STARTERS MSI, MS 4

### GENERAL NOTES

- 1. ALL WIRE TO BE SOLID COPPER THW , 600 VOLT INSULATION
- 2. 480 YOLT WIRING TO BE \$14 EXCEPT AS NOTED.
- 3.120 " " " 12 " " " 4.480 " " COLOR CODED AS FOLLOWS:

PHASE A - BLACK WIRE

PHASE 5 - RED WIRE PHASE C - BLUE WIRE

- 5. GROUNDED 120 VOLT CONTROL WIRE X2 , 1X2 , 4 , TO BE WHITE. G. UNGROUNDED 120 VOLT CONTROL WIRES TO BE RED.
- T. 480 VOLT WIRING TO BE RUN IN TRUNKS SEPARATED FROM 120 VOLT WIRING.
- 8. WIRE BUNDLES TO BE FASTENED WITH PLASTIC TIES AT APPROX 4"INTERVALS.

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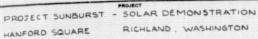
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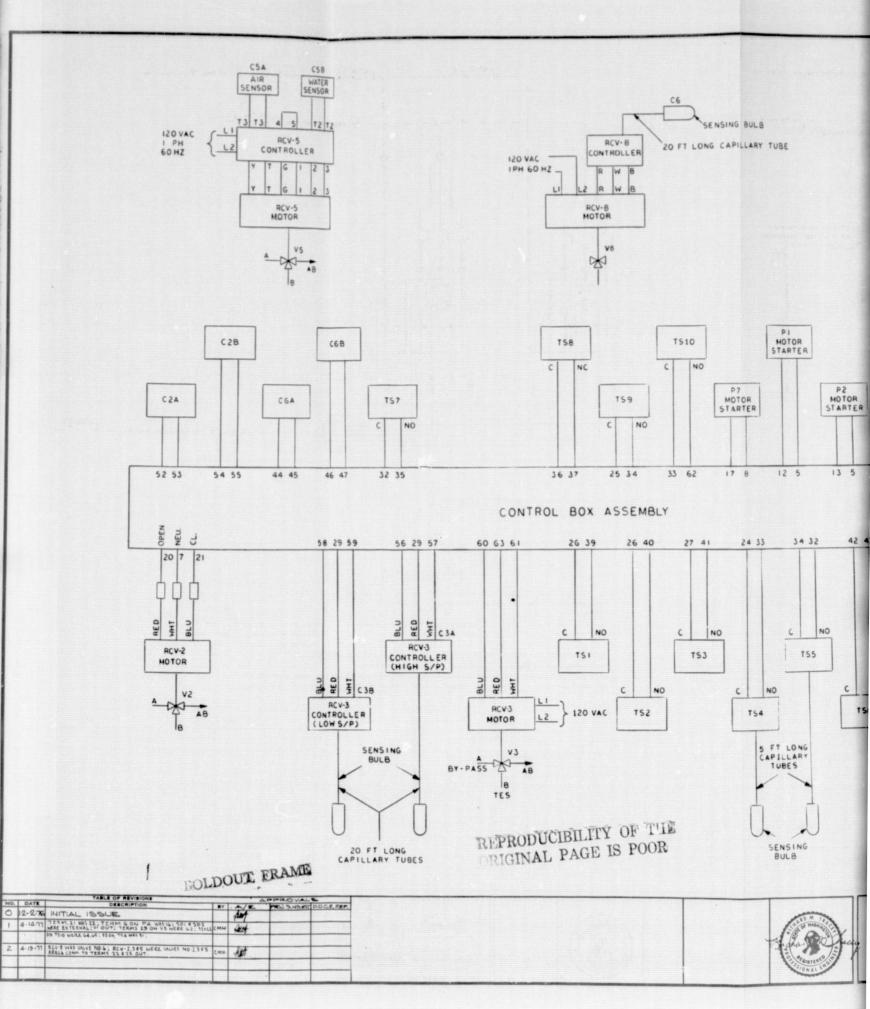


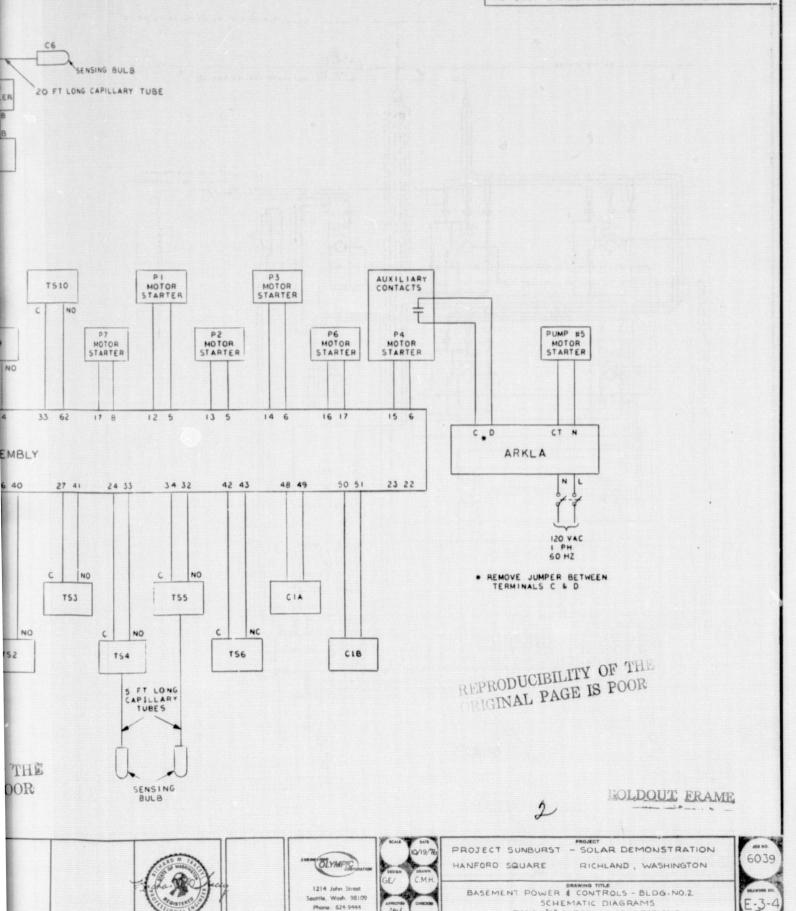


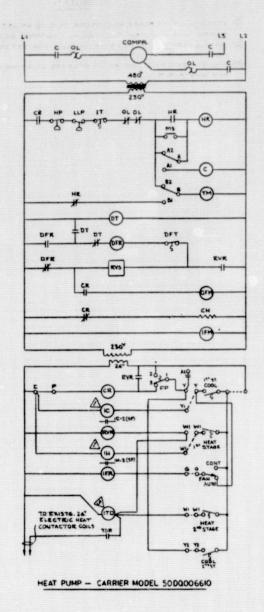
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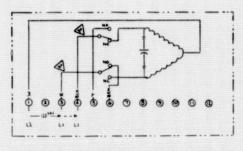
BASEMENT POWER & CONTROLS - BLDG. NO.2 MOTOR STARTER PNLS. WIRING DIAGRAMS











MOTORIZED VALVE - WORCESTER CONTROLS MODEL B73

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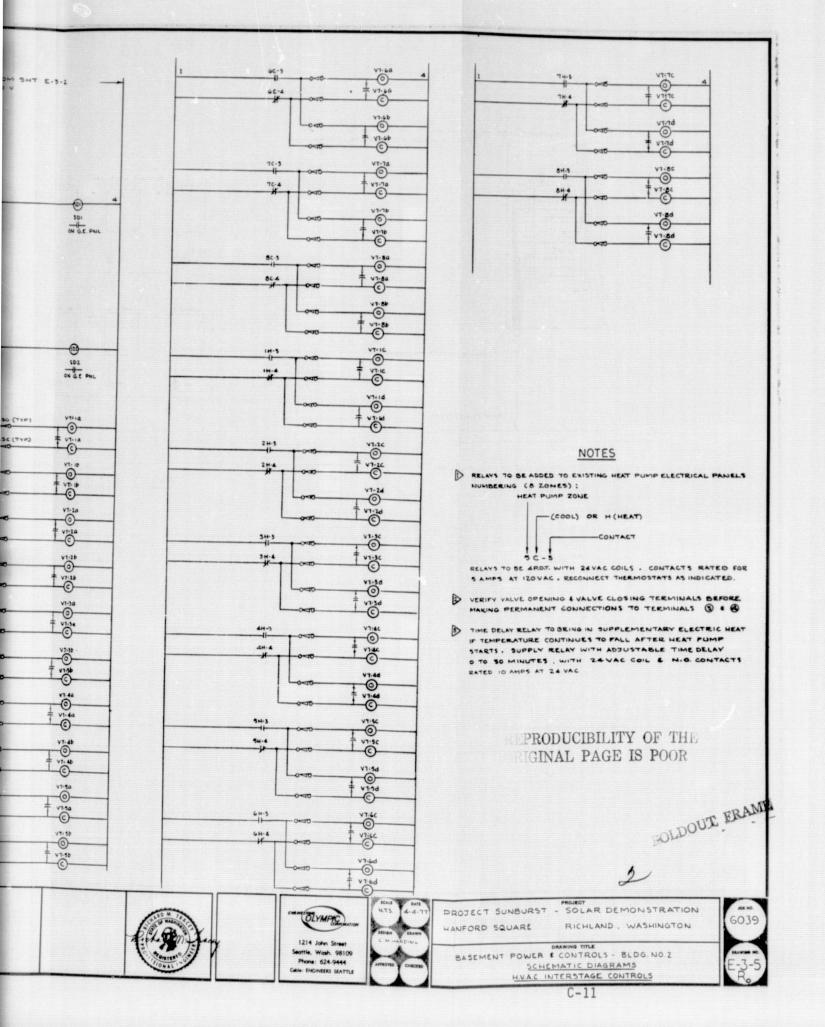
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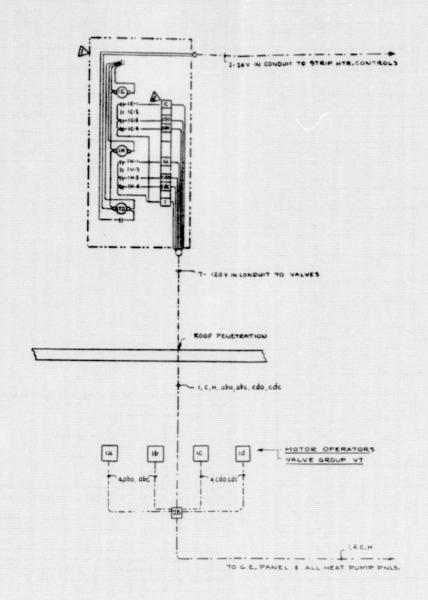
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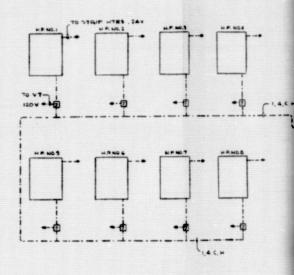
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PANEL INTERCONNECTIONS

RELAY PANEL - HEAT PUMP NO. 1
(TYP) 8 HEAT PUMPS

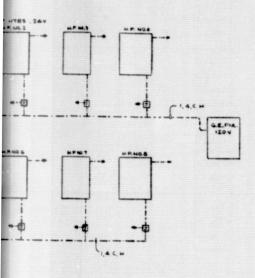
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### NOTES

- ATTACH WEATHER PROOF ENCLOSURE TO SIDE OF HEAT PUMP WITH BACK ENTRY INTO EXISTING ELECTRICAL CONTROL BOX.
- DINSTALL TERMINAL BLOCKS, AS MARKED, FOR EXTERNAL 130 YOUT CONNECTIONS
- D CONNECT THE CELAY RELAY TO OPERATE EXISTING STRIP HEATERS



INTERCONNECTIONS

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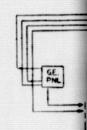
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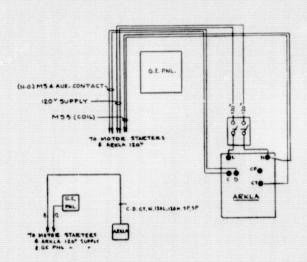
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BASEMENT POWER 4 CONTROLS - BLDG.NO.2 RELAY PANELS





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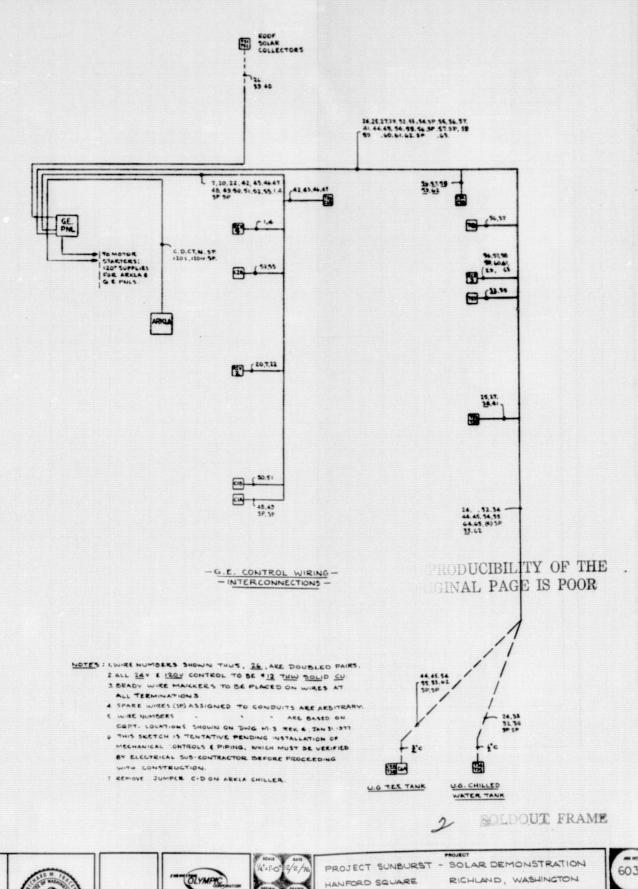


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4-14-77	CONDUIT TO SDI 4 SDZ OUT- ADDED : NOTE 7 SUBTITUE MOTOR INTERCONS TO ARKLA. FLOOR PLAN OUT, VI OUT.	CMH	At-		
4-19.77	TERM 35 WAS STAT TSA; 35 WAS CA GEWAS LS AT TS 10 . 29 WAS GE ARKLA CONN TO GE PHL TERM \$ 22.28 OUT	CMH	elet		
			-		
	2.2.76 5.24-77 4-14-77	DATE CHECKIPTION  72.2.70 INITIAL ISSUE  5.24.71 REDRAWN  4.14.77 COUDING TO SDI4 502 OUT. ADDED: NOTE 7, SMRTILL HOTOR INTERONS TO ARKLA. PLOOR PLAN OUT, VI OUT.  TERM SWIN 31 KT 37.3 3 M 356 4 MM 56 KT 37.0 I SMM 54.	DATE DESCRIPTION BY  [2.2.76 INITIAL ISSUE  5.24-77 REDRAWN CMH  4-16-77 CONDUIT TO SDI 6 502 OUT. ADDED: NOTE 7 SUSTITUE CMH  WOTON INTERCONS TO ARREA. FLOOR PIAN OUT, VI OUT. 1  TERM SWIND SIX TO 3. 33 MISS G. SIMS SIS ST 501. 35 MIS SIX	DATE GERCHITION BY  Z2_76 INITIAL ISSUE  3.24-77 REDRAWN  CMM UP  TERM SWID 18 TO SD14 SD2 OUT, ADDED; NOTE 1, SUSTILLE CMM  WOOD INTERCOMS TO ARKLA, FLOOR PLAN OUT, VI OUT CMM  TERM SWID 518 THAL 33 MASS CA 1948 55 88 TS 0.1 59 MS C.  JUL.	DATE GERCRIPTION BY ACK PROS SUMBLIST TO RECORD TO SUMBLIST TO RECORD TO SPECIAL TO SOME SESTION TO SPECIAL TO SPEC







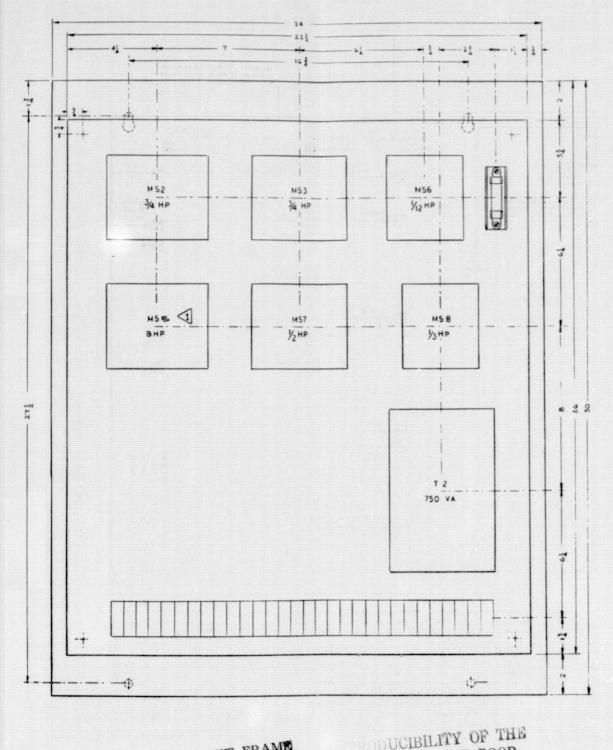


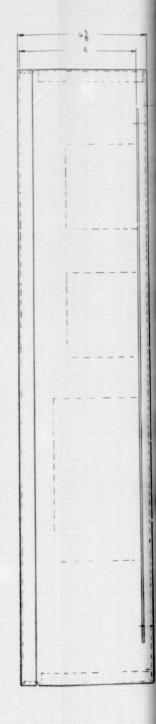
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BASEMENT POWER & CONTROLS - BLDG, NO. 2 INTERCONNECTIONS







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#### EQUIPMENT

ITEM	QUANTITY	DESCRIPTION
1	1	Enclosure, panel, NEMA type 1, overall dimensions 30 high x 24" wide x 6 5/8" deep, Heffman Engineering Co. cat. # A-30N24A
2	1	Panel, steel, white enamel, 12 guage, 26" high x 20's wide, for Hoffman Engineering Co. enclesure item 1
3	1	Control trac former, 480/120 volts, 750 YA, Square D cat. #E0-61
4	1	Fuse block, single pole, 250 volt, 1-30 amps., Allem Bradley cat. #1491-N121
5	1	Terminal block assembly, 600 velt, channel mounted, 30 circuits, Square D class 9080, type KD30
6	1	Fuse, cartridge, 250 volt, Bussman #FRK7
7	1	Magnetic starter, open type, 460 velt, separate 120 volt control, NEM size 00, Allan Bradley cat. 4709-T00103, three phase, with 3 overlead relay heaters cat. #NEM: for & h.p. saster
8	2	Ditto, with 3 overload relay heaters cat. #Nil for 3/4 h.p. motor
9	1	Ditto, with 3 overload relay besters eat. #67 for 1/2 h.p. motor
10	1	Magnetic starter, open type, 460 welt, separate 120 wolt centrol, NEMA size 00, Allem Bradley cat. f 709-T00103, single phase, with one everload relay heater cat. fN27 for 1/3 h.p. meter
11	1	Ditte, with one overload relay heater est. #818 for l/m h.p. meter

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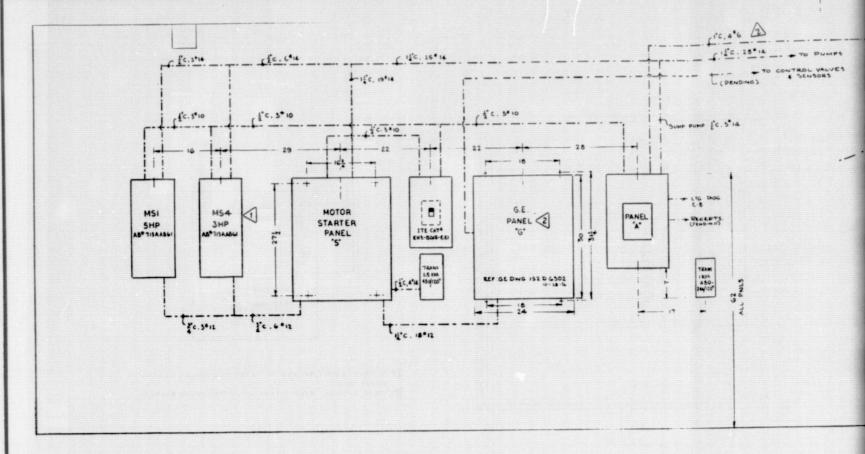
Phone: 624-9444
Cable: ENGINEERS SEATTLE



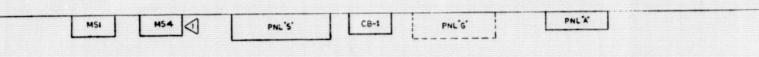
PROJECT SUBBURST - SOLAR DEMONSTRATION HANFORD SQUARE RICHLAND, WASHINGTON

BASEMENT POWER & CONTROLS - BLDG, NO. 2
-EQUIPMENT & CONDUIT LAYOUTS MOTOR STARTER PANEL





ELEV.



PLAN

ELECT. EQPT. LAYOUT - NORTH WALL

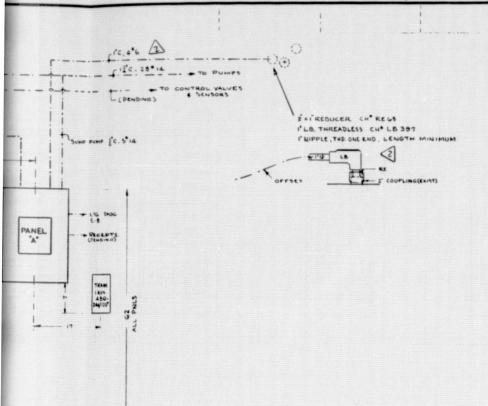
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-		TABLE OF REVISIONS		APPROVAL5	
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0	11-11-76	ILITIAL 199LE	EMH	fuct	
1	12.2.76	15 S CHANGED TO MS 4	11	LUH	
3	1-4-17	ED NOTES 1-4, PNL'G' DIMS , CONDT. DETAIL,	СМН	414	
			+		
-			+-		





EQUIPMENT

ITEM	QUANTITY	DESCRIPTION
1	1	Transformer, dry type, 480/240 volt primary, 240/120 volt secondary, 1.5 KVA, single phase, G.E. cat. #9751Y11
2	1	Ditto, 1.0 KVA, G. E. cat. #9751Y10
3	1	Circuit breaker, enclosed, NEMA 1, 100 A frame, 15 A trip, 480 volt, heavy duty, 3 pele, I.T.E. cet. #EH3-8015-EE1
•	1	Panelboard, lighting & distribution, surface mounting 18 poles, 9 spaces, 100 amp. main lugs, Westinghouse panel MHSA-18-4L-100, with box FYX1523 and Fastrim FFXX-1523
5	1	Circuit breaker, belt-on, for MMBA panel, Mestinghous type BA, single pole, 15 A
6	1	Ditto, 2 pole, 15 A
7	1	Ditto, 3 pole, 20 A
8	1	Ditto, 3 pele, 30 A
,	1	Combination starter, NEMA 1, 460 velt, separate 120 volt control, size 0, Allen Bradley cat. #M8713 AAB61 with 3 overlead relay heaters cat. #M29 for 5 k.p. mater
10	1	Ditto, with 3 heaters cat. PR24 for 3 h.p. motor

GENERAL NOTES

I. ALL WIRE : COPPER . THW INSULATION .

\*14 TO \*8 : SOLID

2. CONDUIT : RIGID, GALV, THREADED EXCEPT AS NOTED.
3. CONDUIT ENTRANCES NOT TO SCALE, RELOCATE IN FIELD TO SUIT

K.O. LOCATIONS ON ENCLOSURES.

4 GROUND CONDUIT TO C.W.S. PIPE. CONTINUITY OF GROUNDING TO BE MAINTAINED AT PANELS, ENGLOSURES & EXPOSED METAL PARTS. GROUND WIRE \*4 COPPER.

PNL A

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2





Seattle, Wash. 98109 Phone: 624-9444

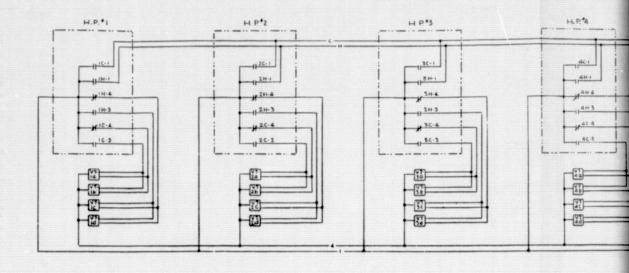


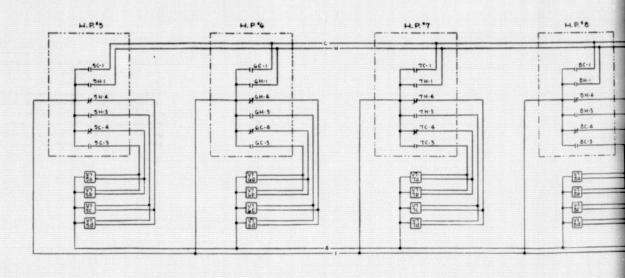
PROJECT SUNBURST - SOLAR DEMONSTRATION HANFORD SQUARE

RICHLAND , WASHINGTON

BASEMENT POWER & CONTROLS - BLDG, NO. 2 -EQUIPMENT & CONDUIT LAYOUTS -POWER DISTRIBUTION CENTER







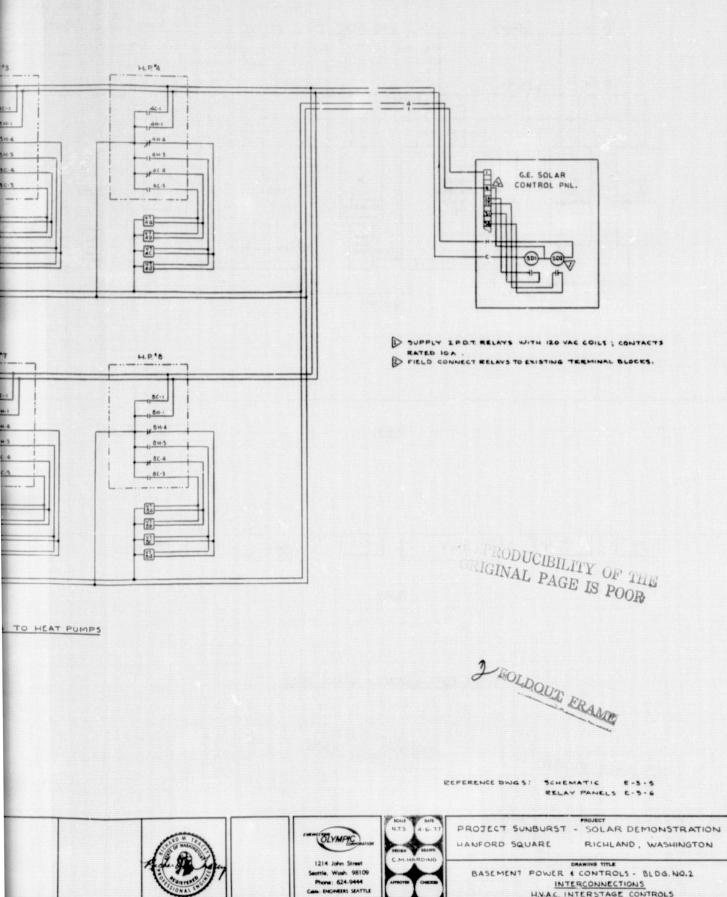
SOLAR PANEL CONNECTIONS TO HEAT PUMPS

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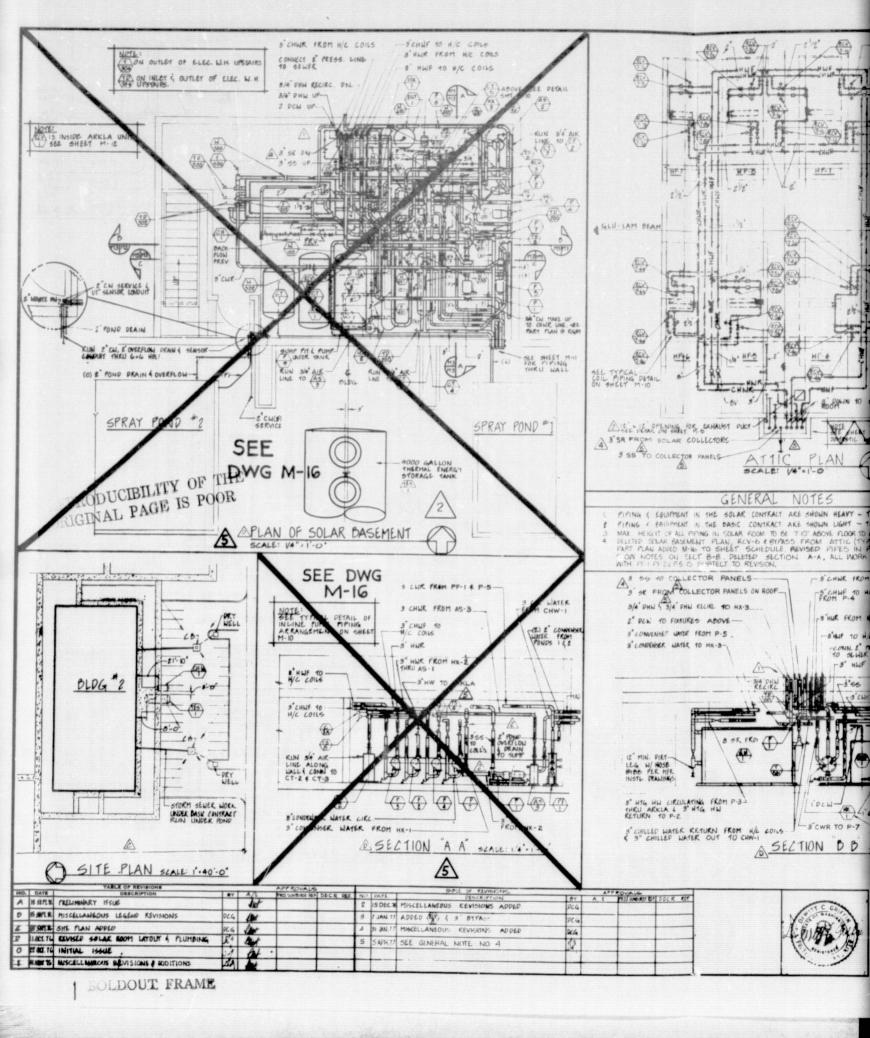
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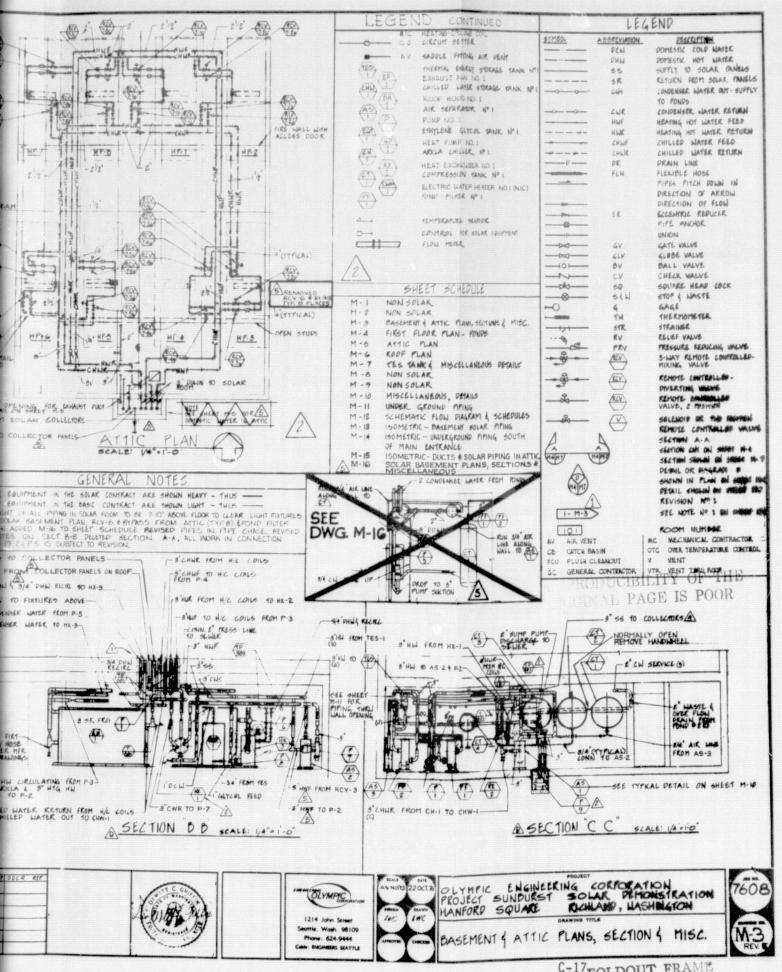
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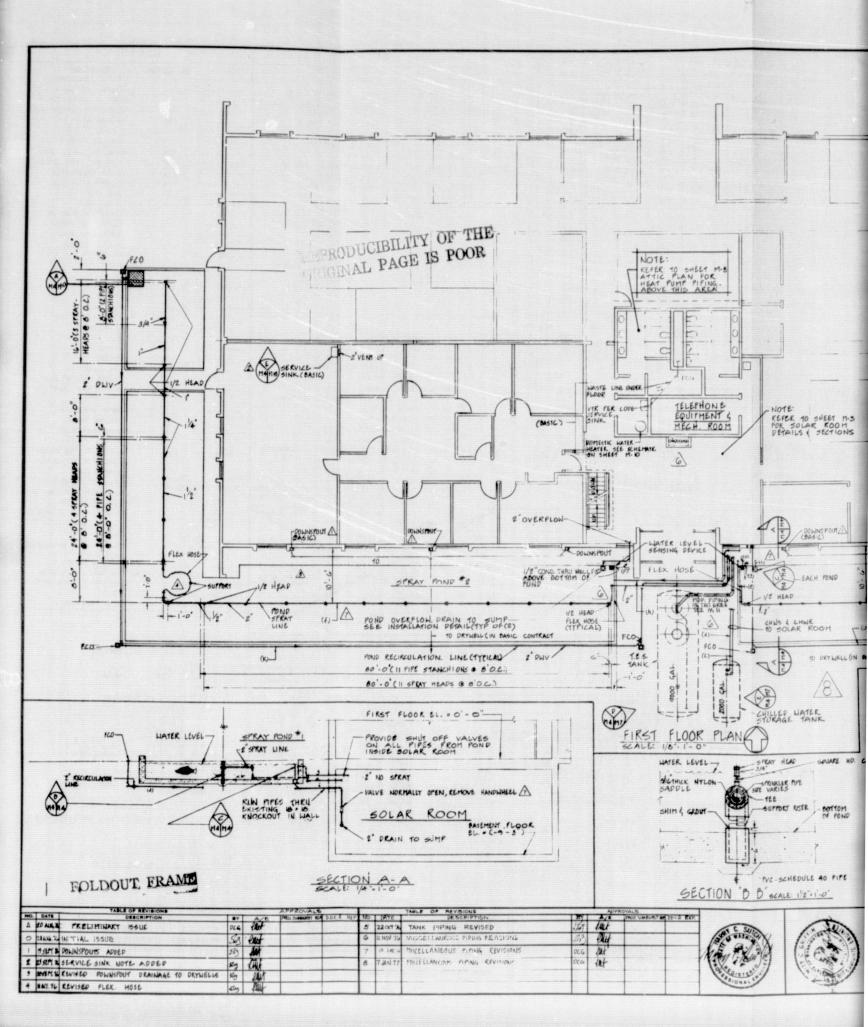


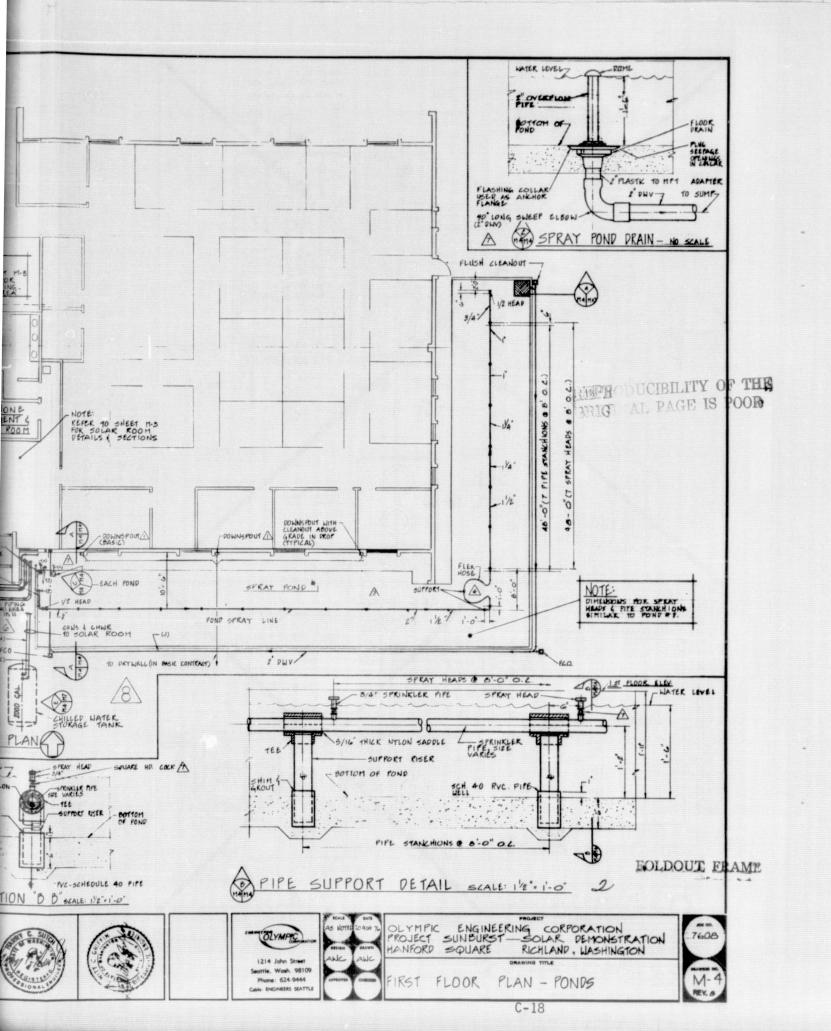
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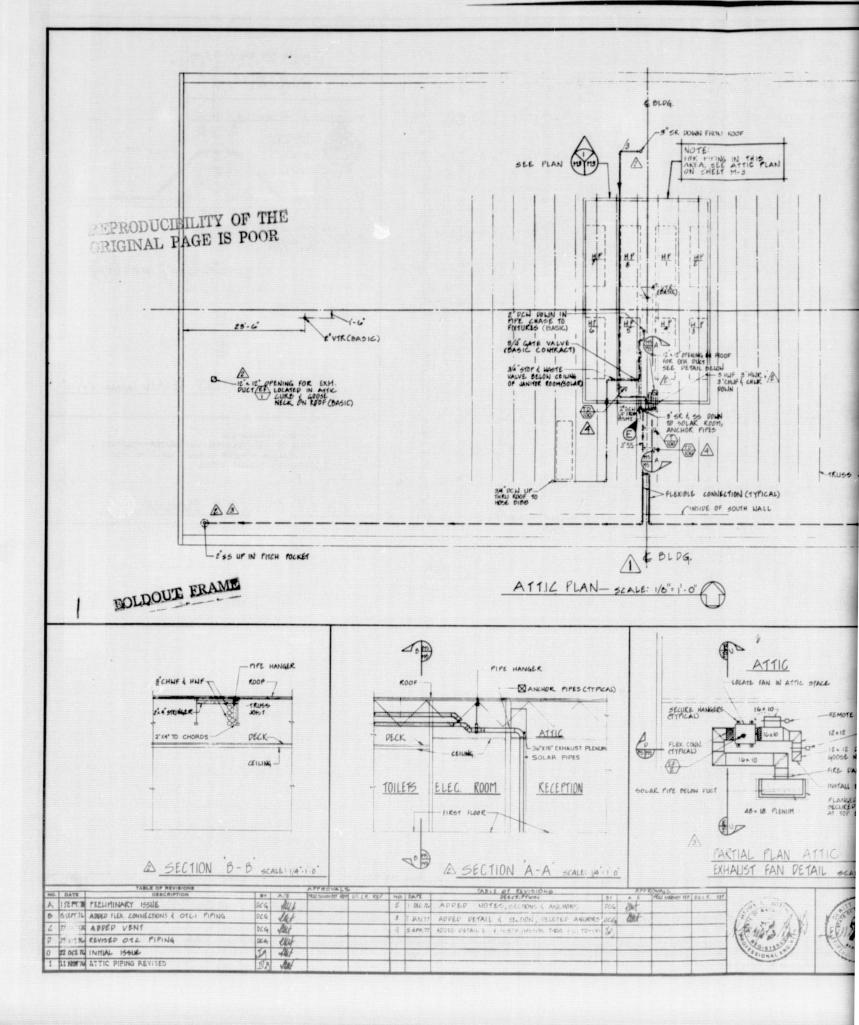


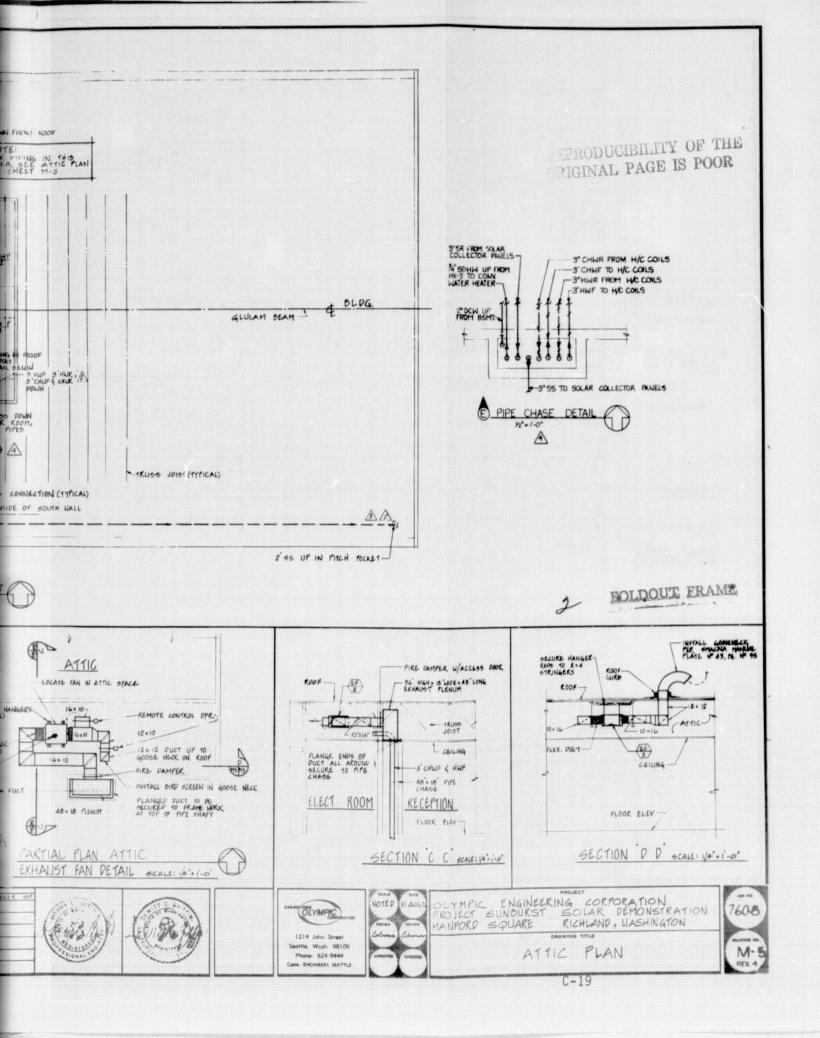


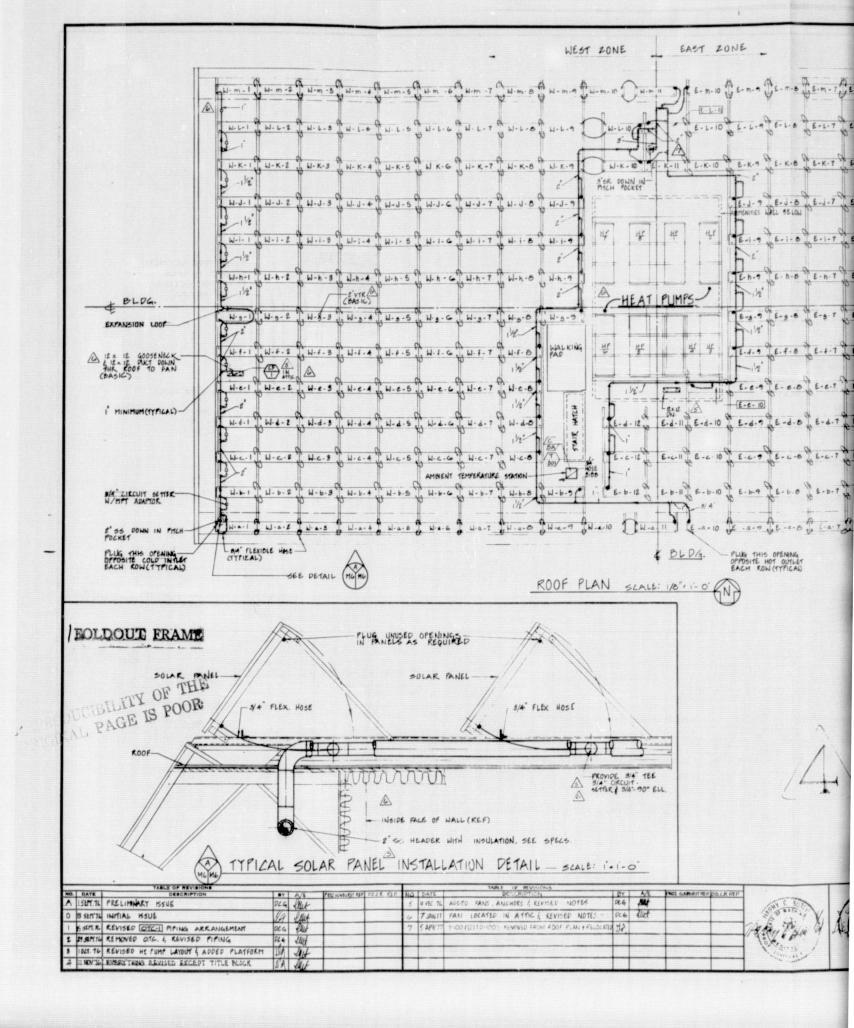
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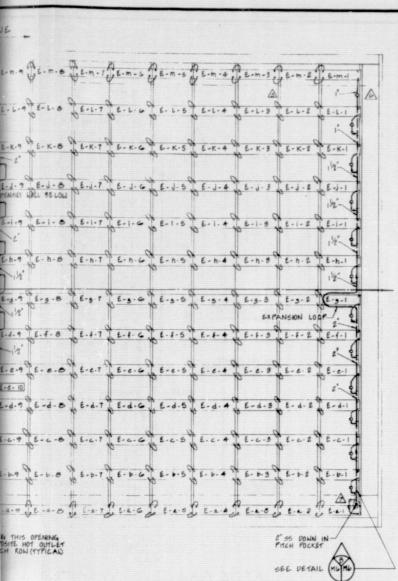


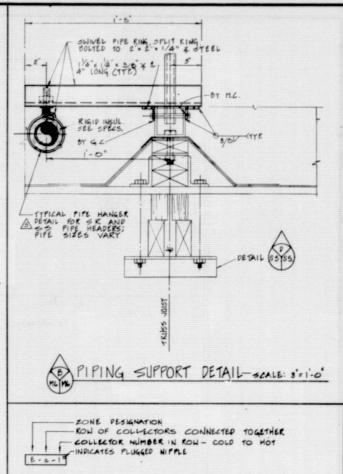












SOLAR COLLECTOR DESIGNATIONS

2 MORDOUT FRAME

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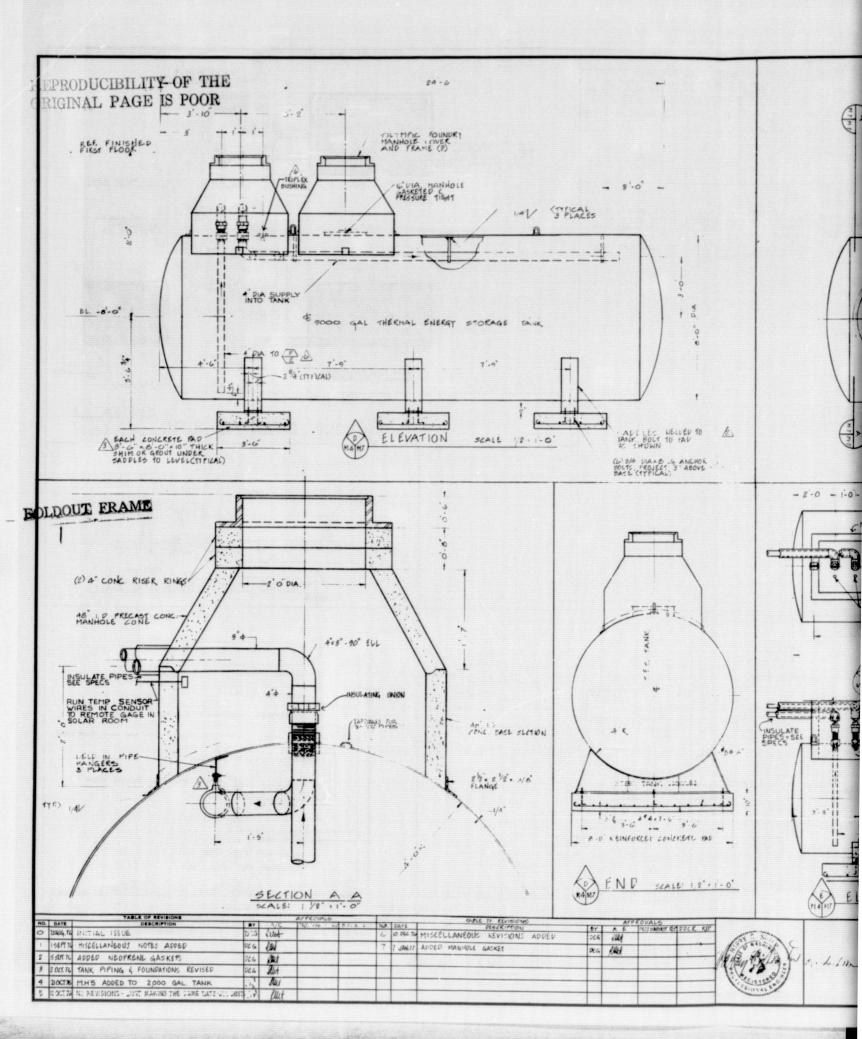
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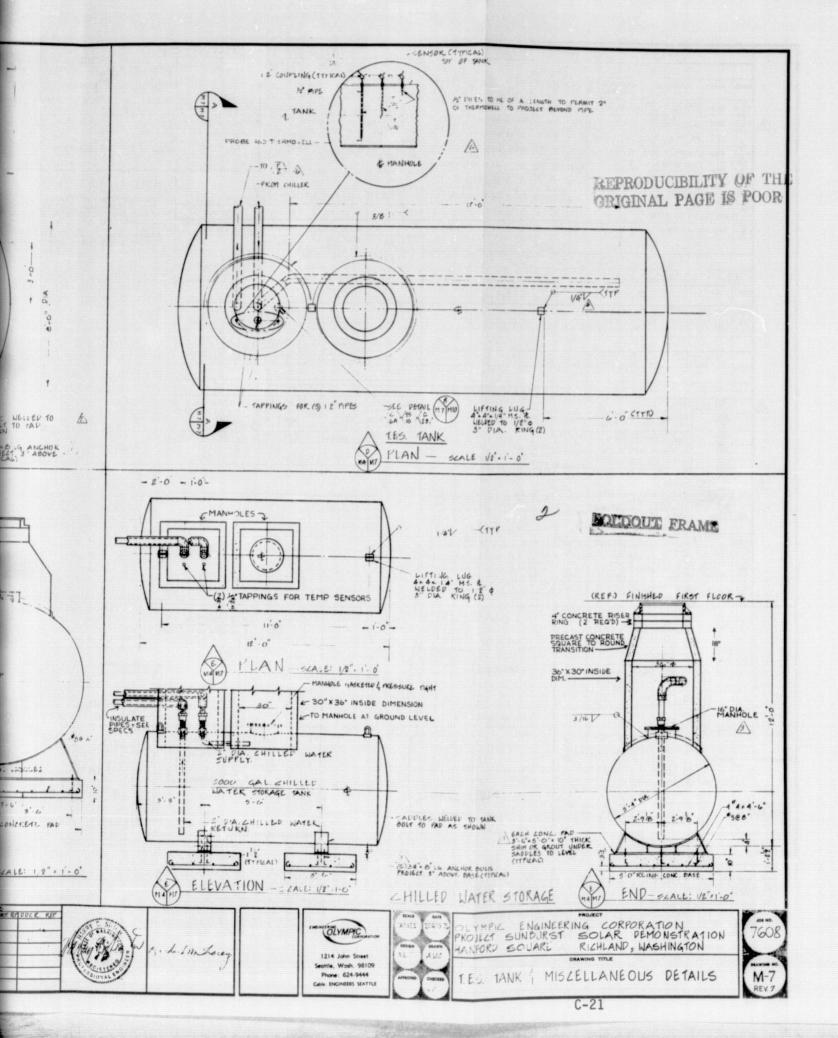


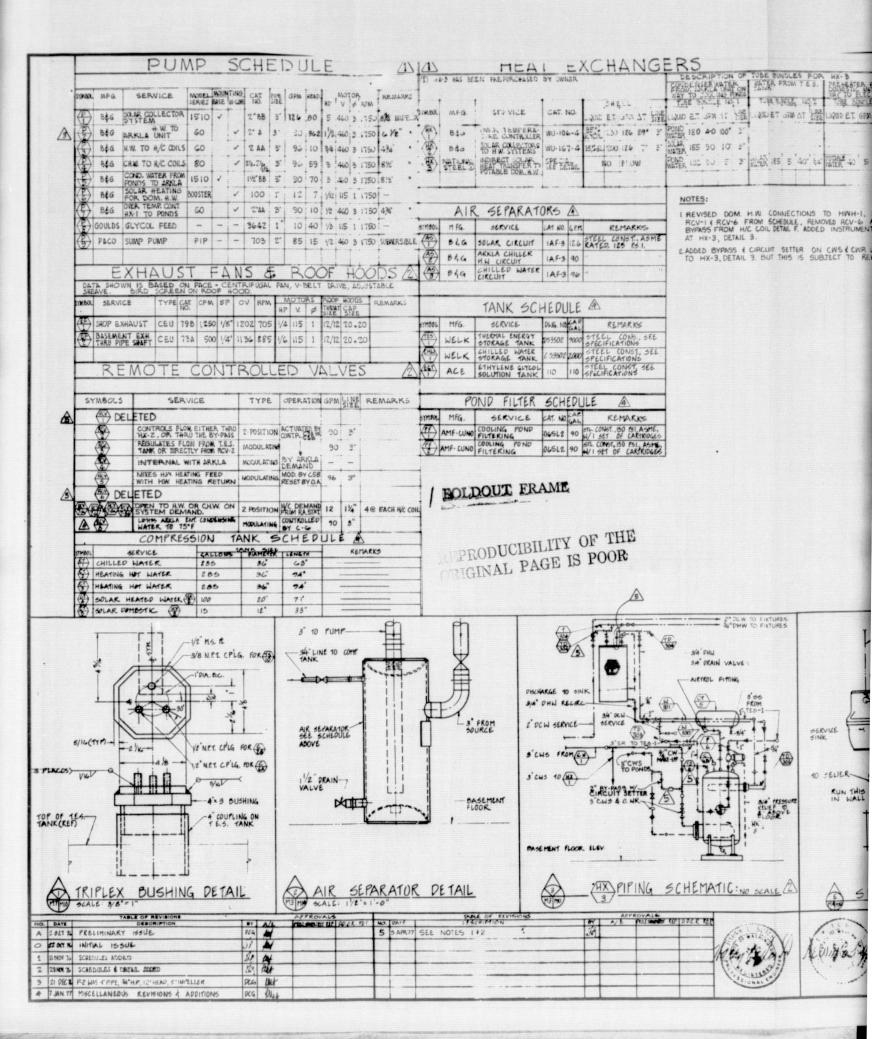


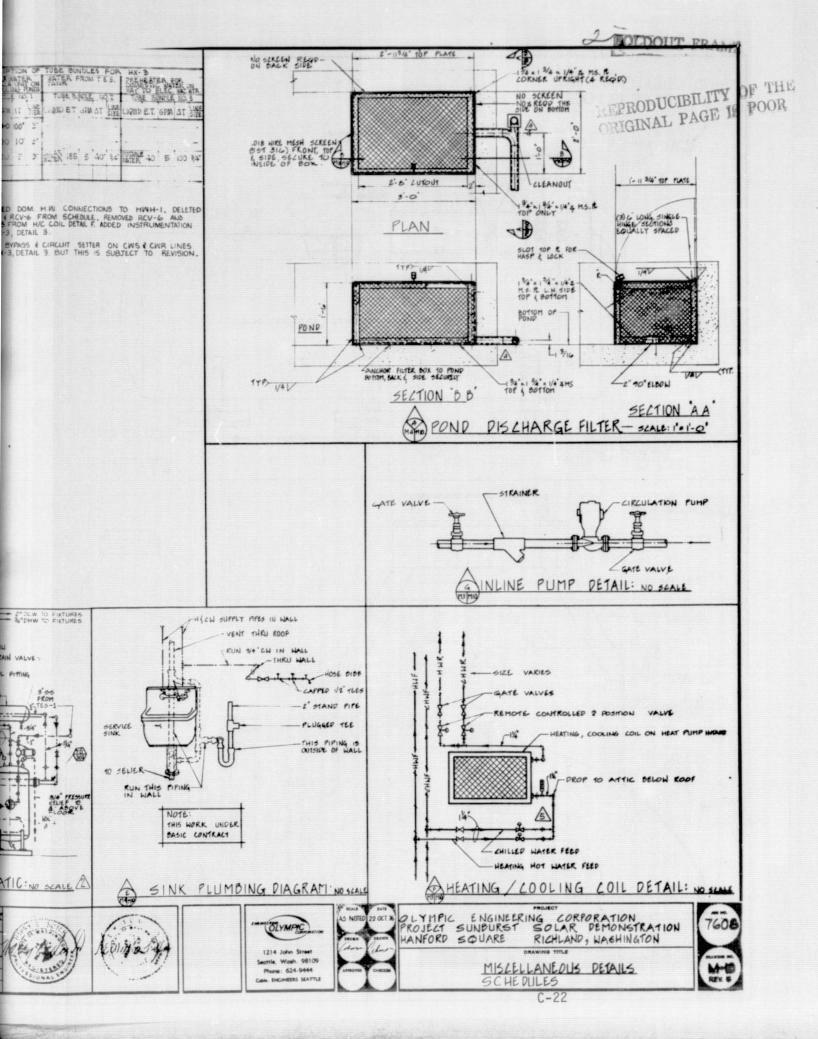
ROOF PLAN



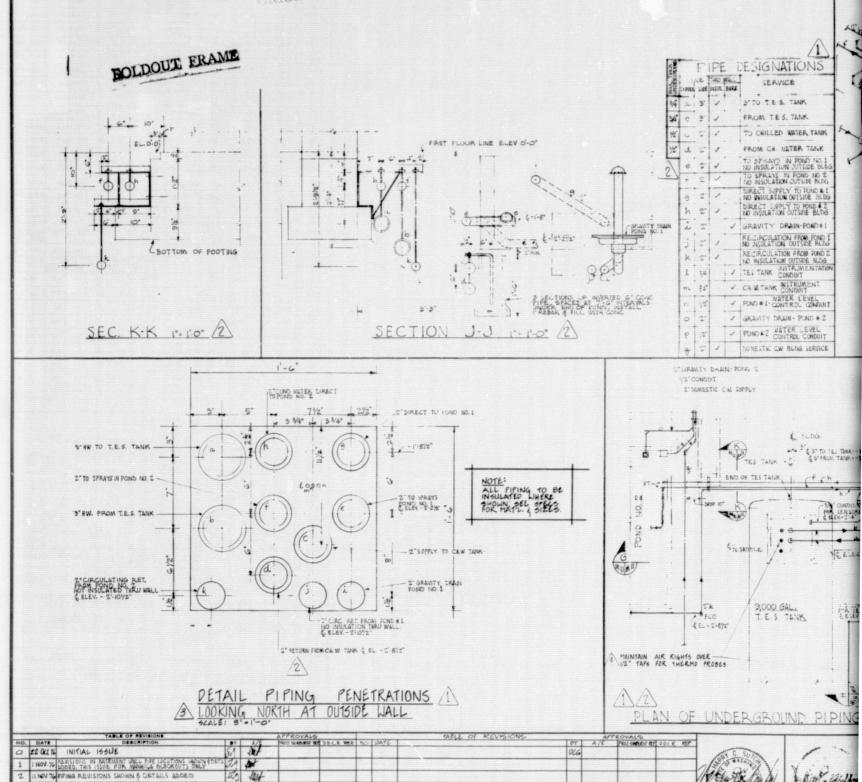








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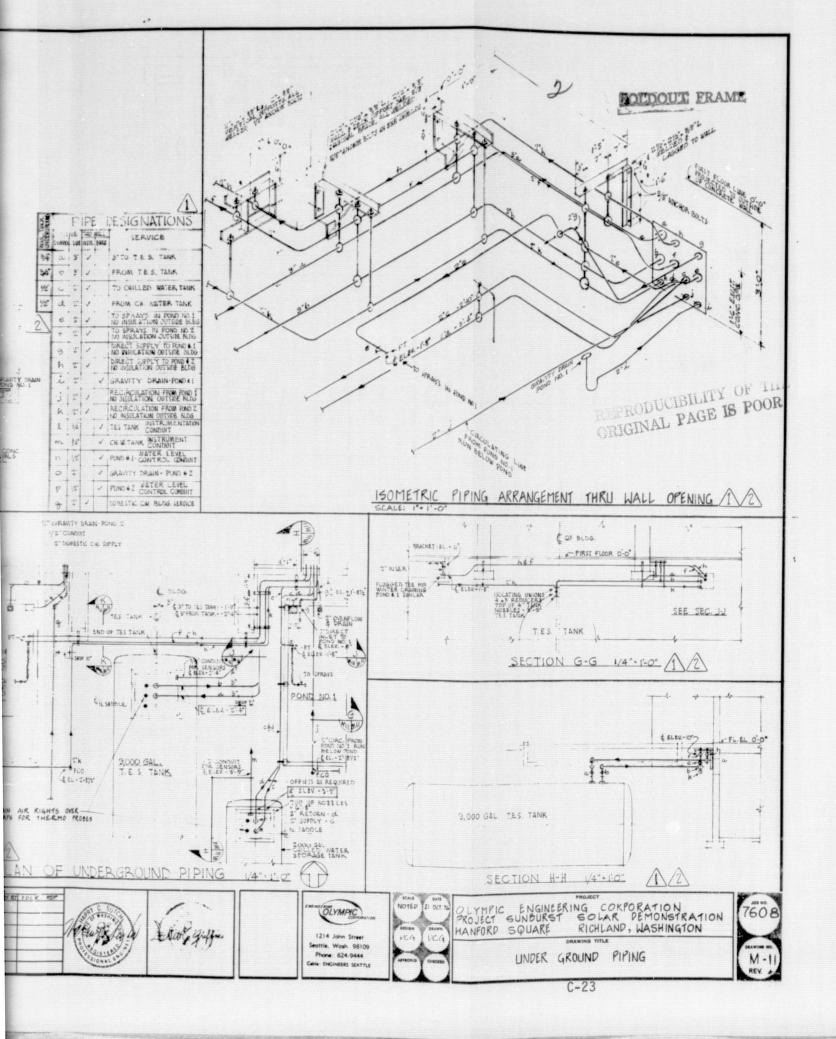


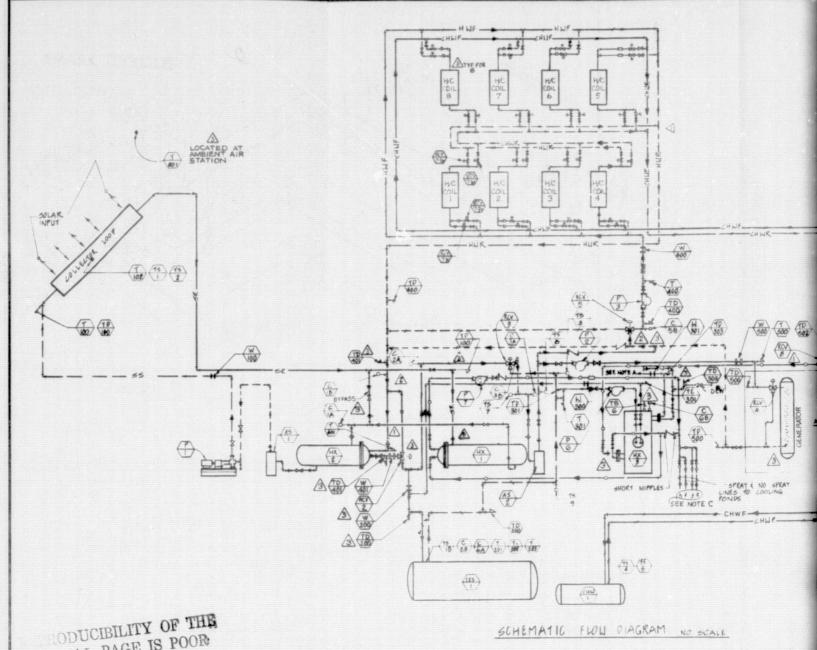
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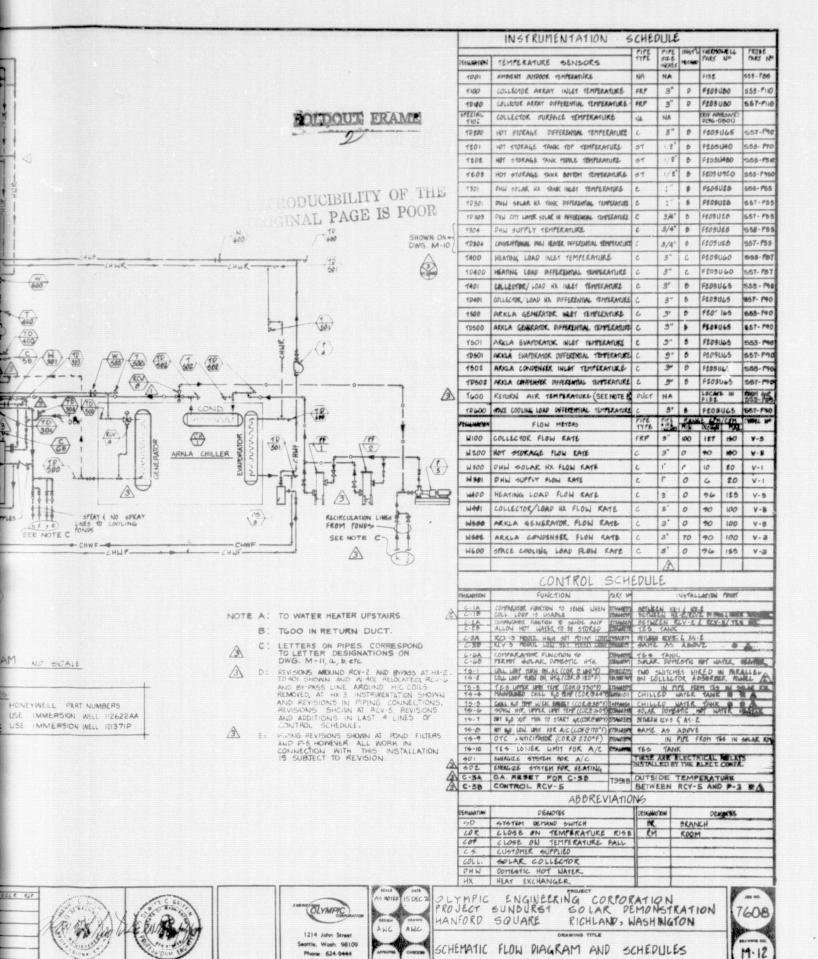
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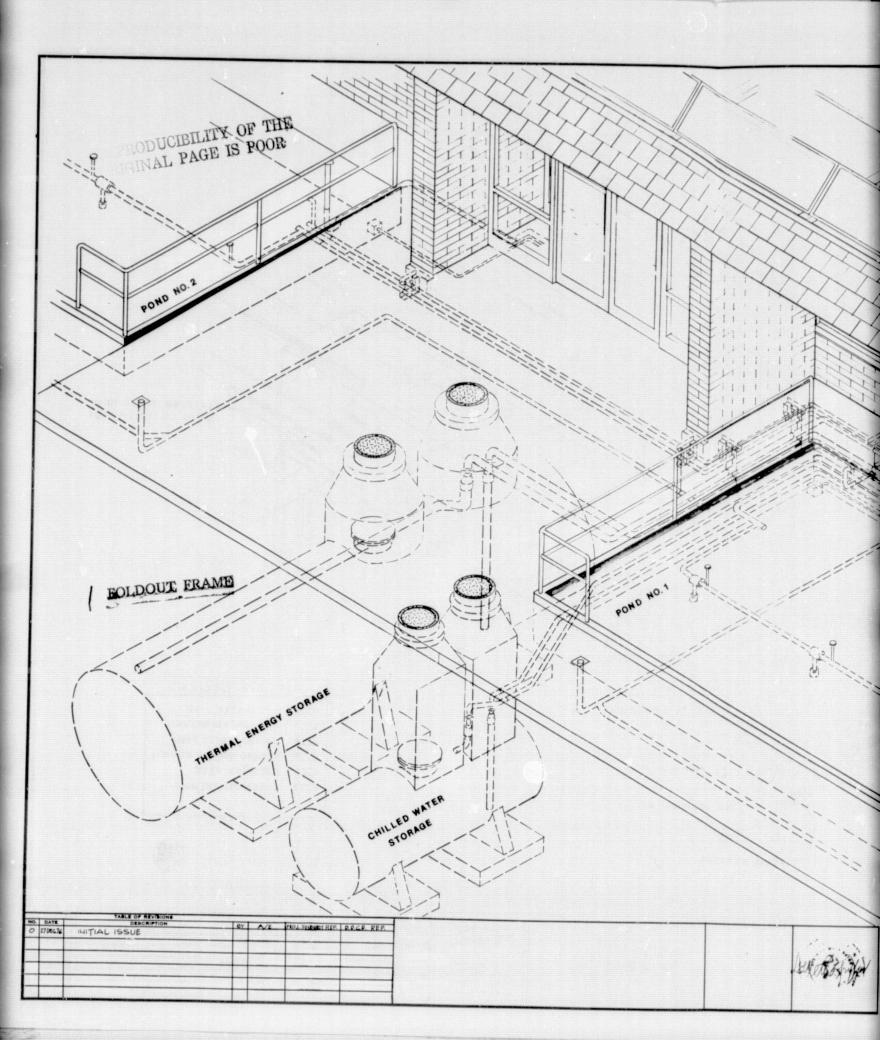
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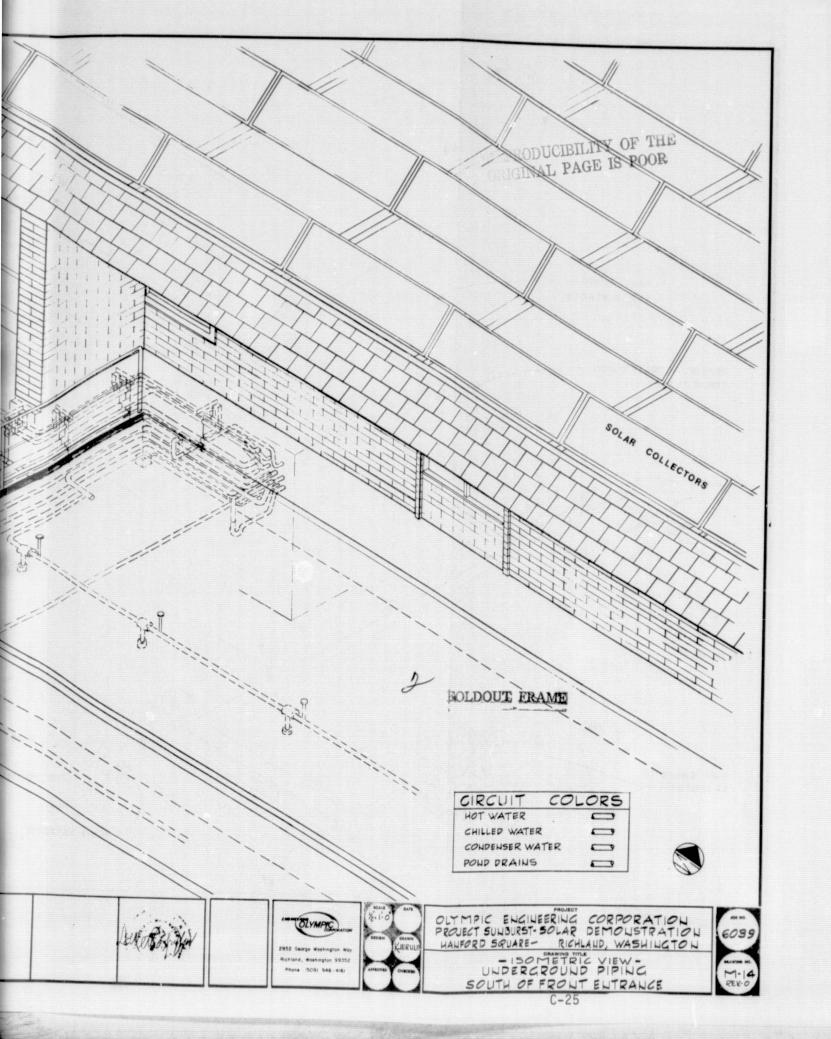
WHAT USE IMMERSION WELL 121371P

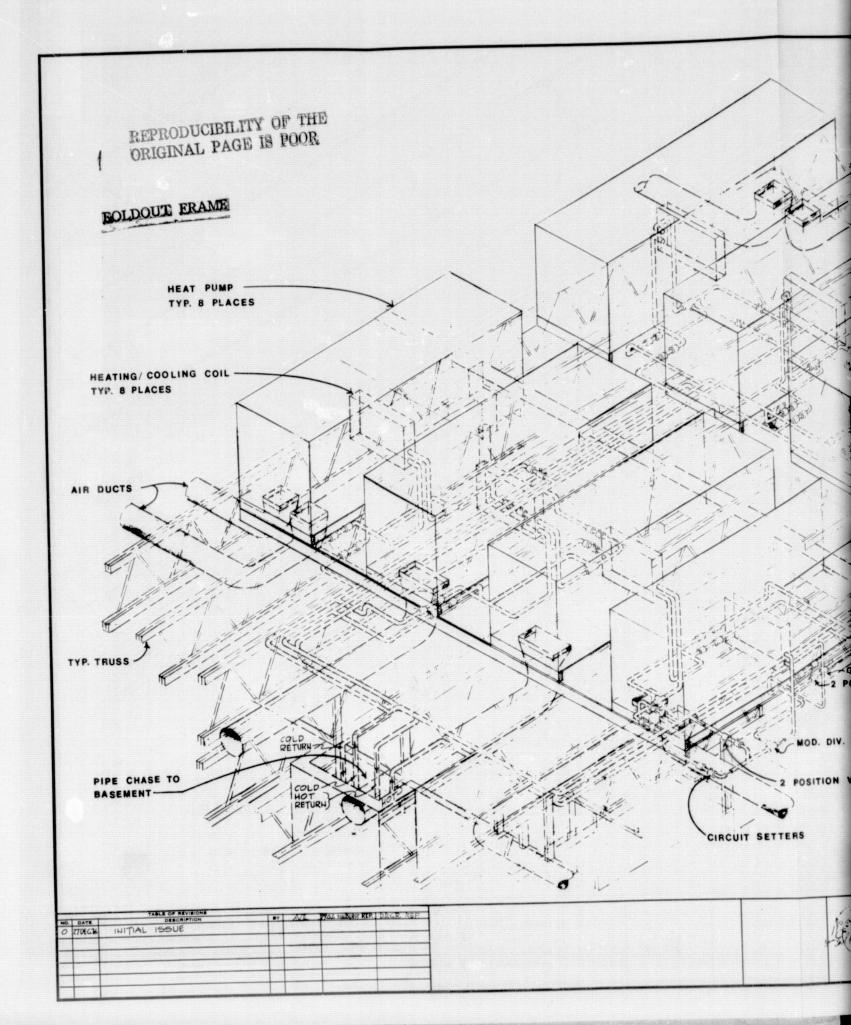


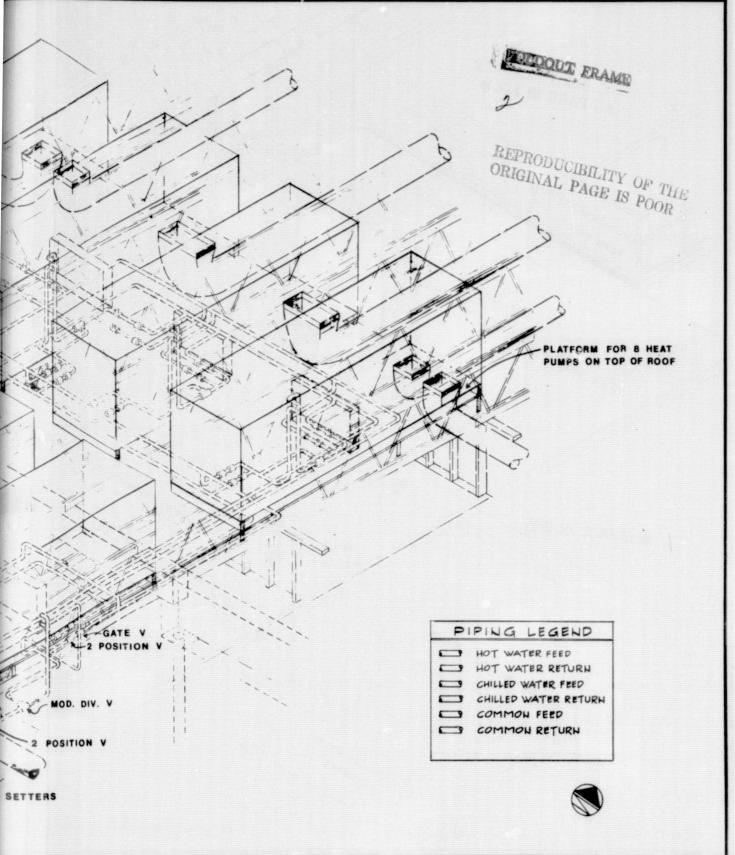
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0	15 DEC.76	INITIAL ISSUE	006											A CONTRACT
1	7 JAN 17	ADDED & BYPASS , MISC. REVISIONS	204	that										NE MINA
t	91 JAN 77	MISCELLANEOUS MENSIONS ADDED	ocq											MAN WAS JOHN W
3	5 APR 77	SEE NOTES C, DAT	30											1 ( 119)
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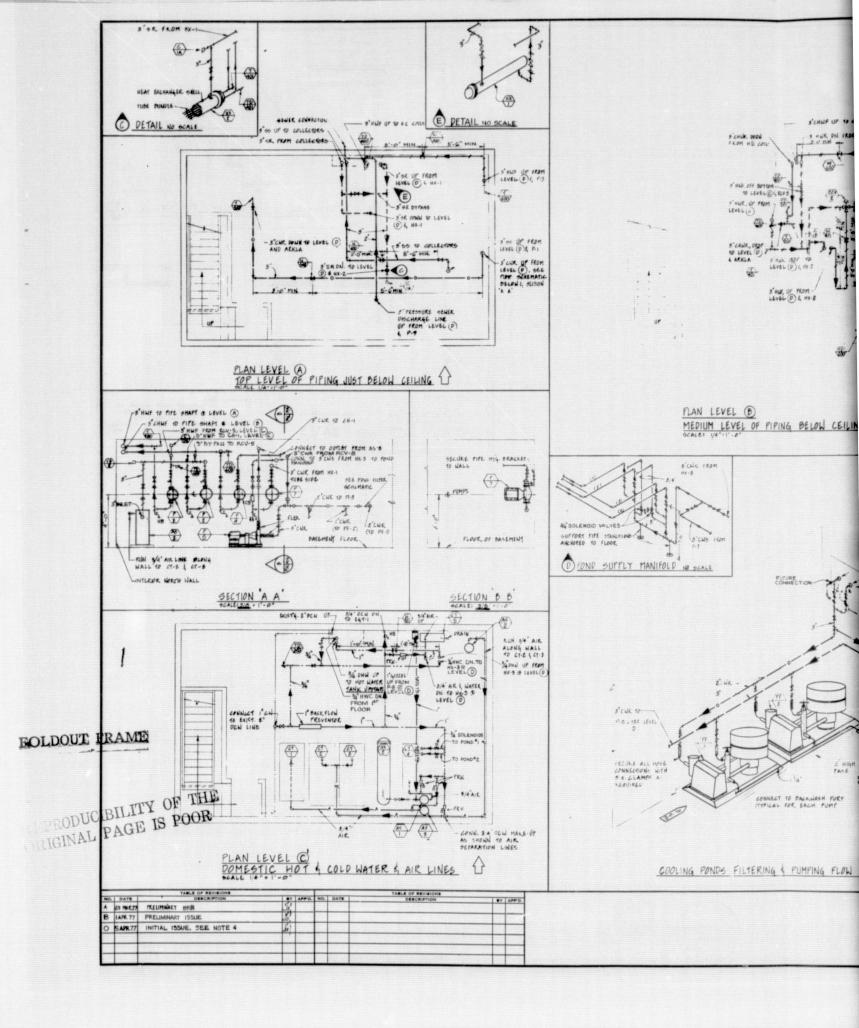
1214 John Street Seattle, Wash. 98109 Phone: 624-9444 Cells: EMGINEERS SEATTLE

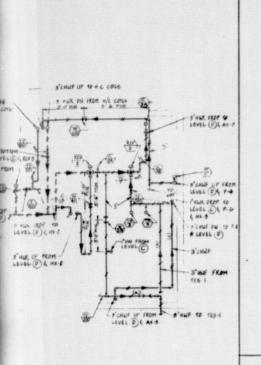


OLYMPIC ENGINEERING CORPORATION PROJECT SUNBURST- SOLAR DEMONSTRATION HANFORD SQUARE- RICHLAND, WASHINGTON

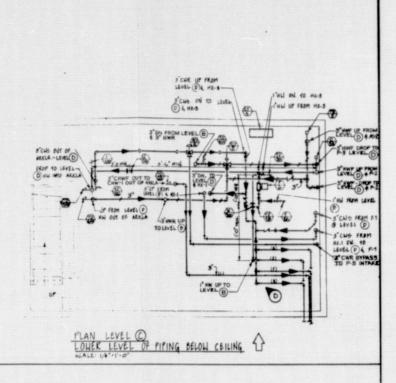
- ISOMETRIZ VIEW -DUCTS & SOLAR PIPING IN ATTIC TO HEAT PUMPS ON ROOF







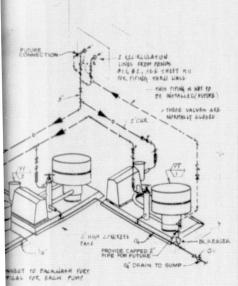
F PIPING BELOW CEILING

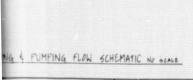


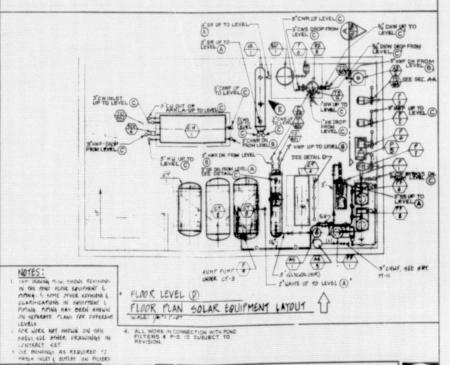
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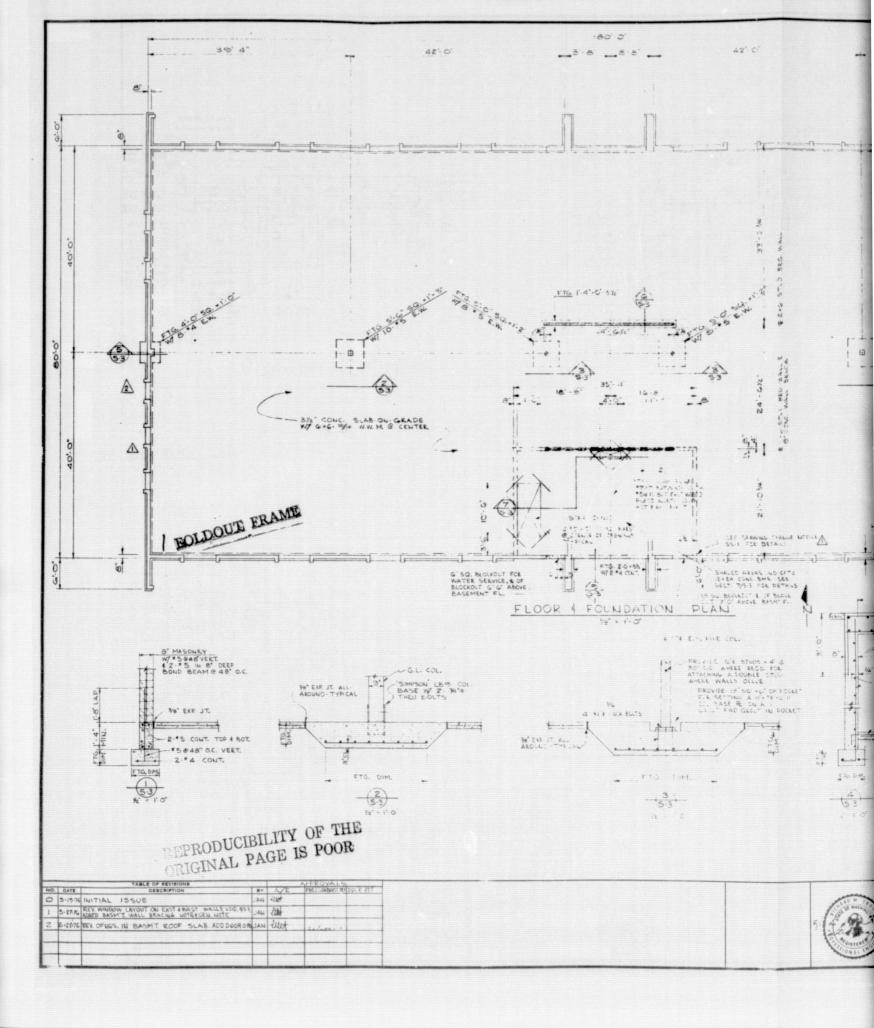


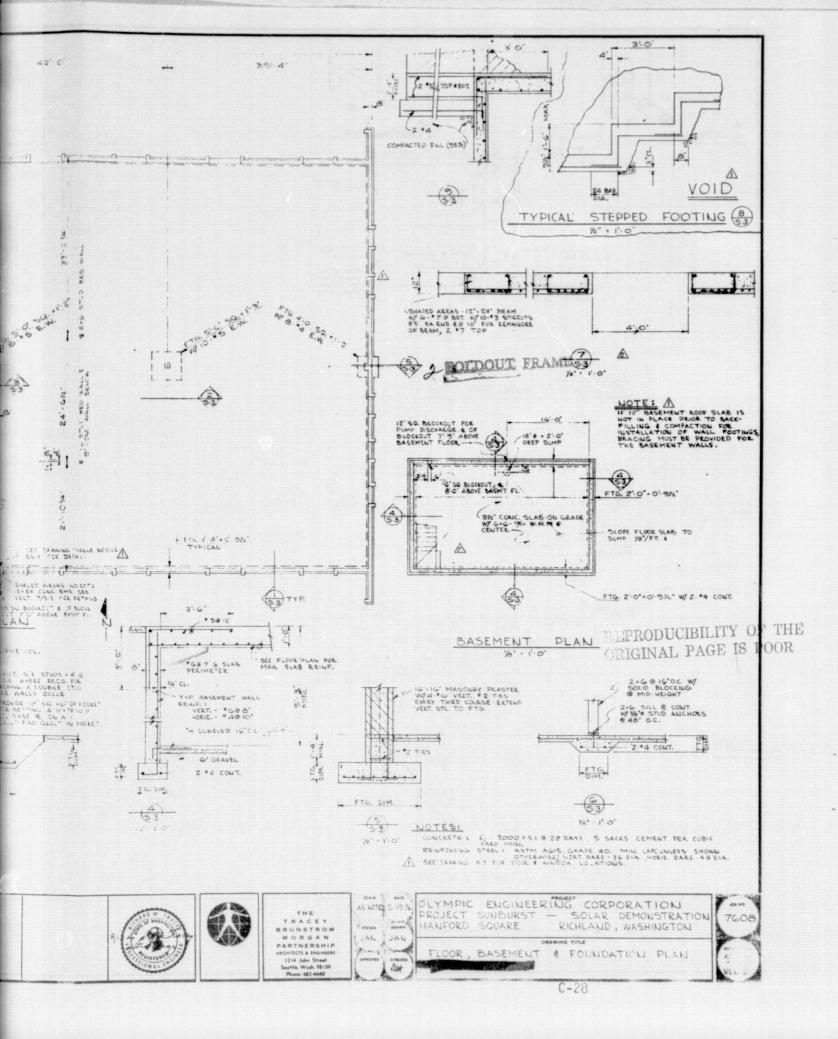


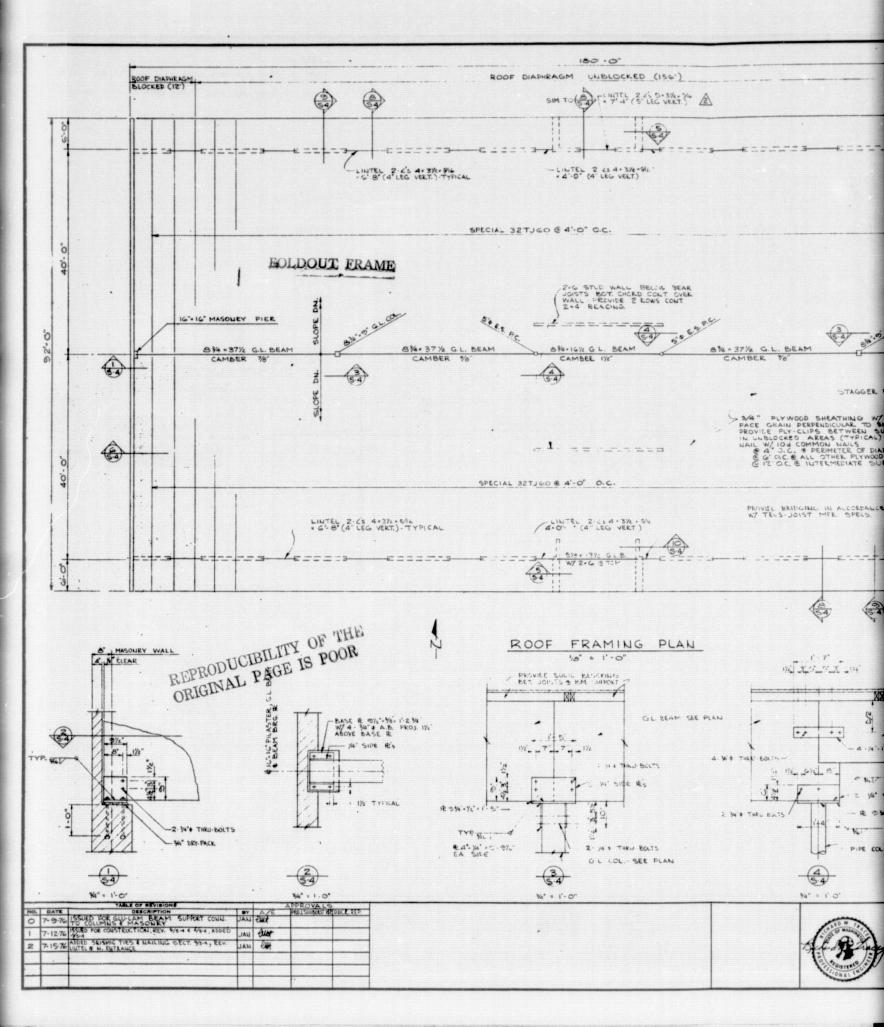
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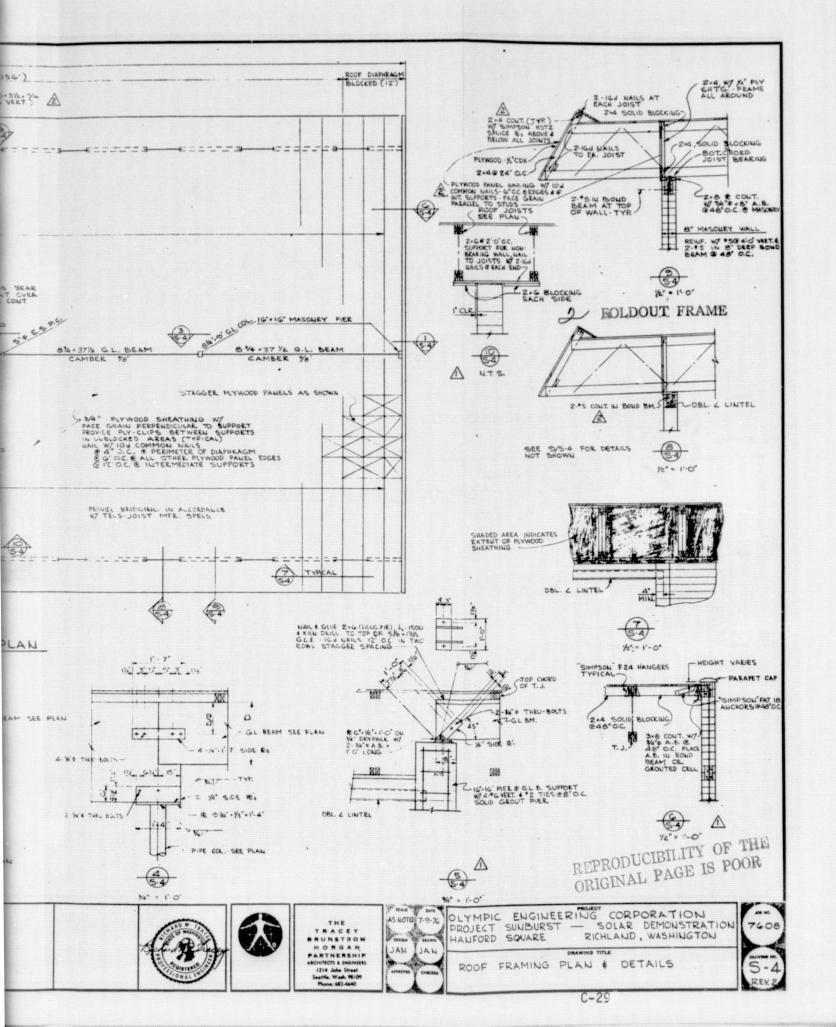
SOLAR BASEMENT PLANS, SECTIONS & MISC.





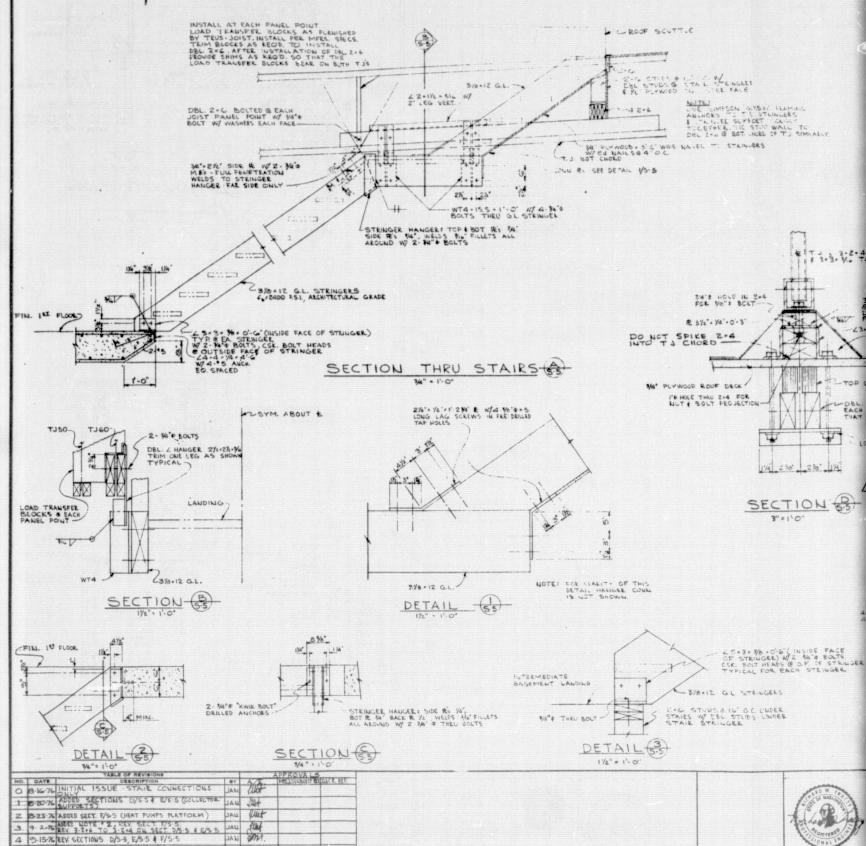






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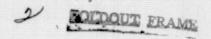
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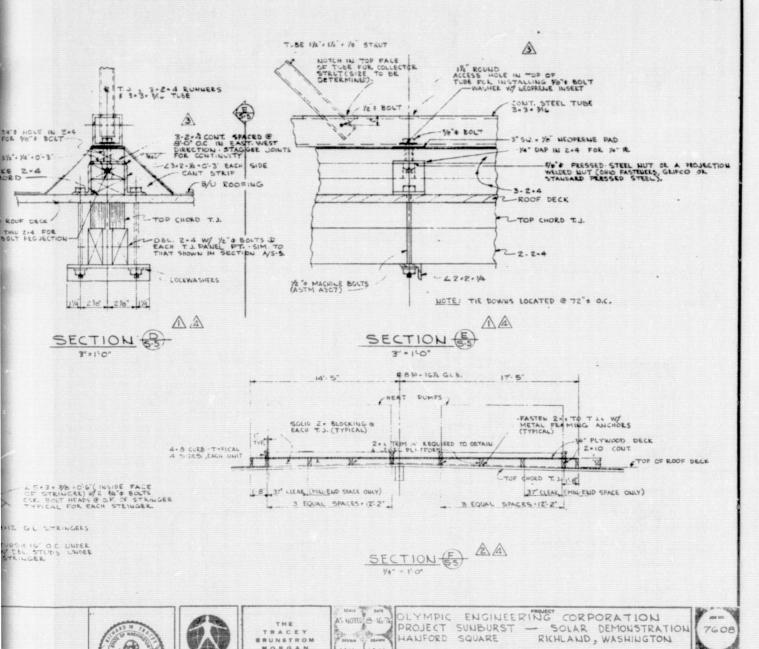


## MOTES:

- I. PROVIDE ROUND WASHERS UNDER ALL MUTS OR BOLT HEADS BEARING ON WOOD.
- 2. PAINT EXPOSED CARR. BOLT HEADS NUTS ON STAIR STRINGERS



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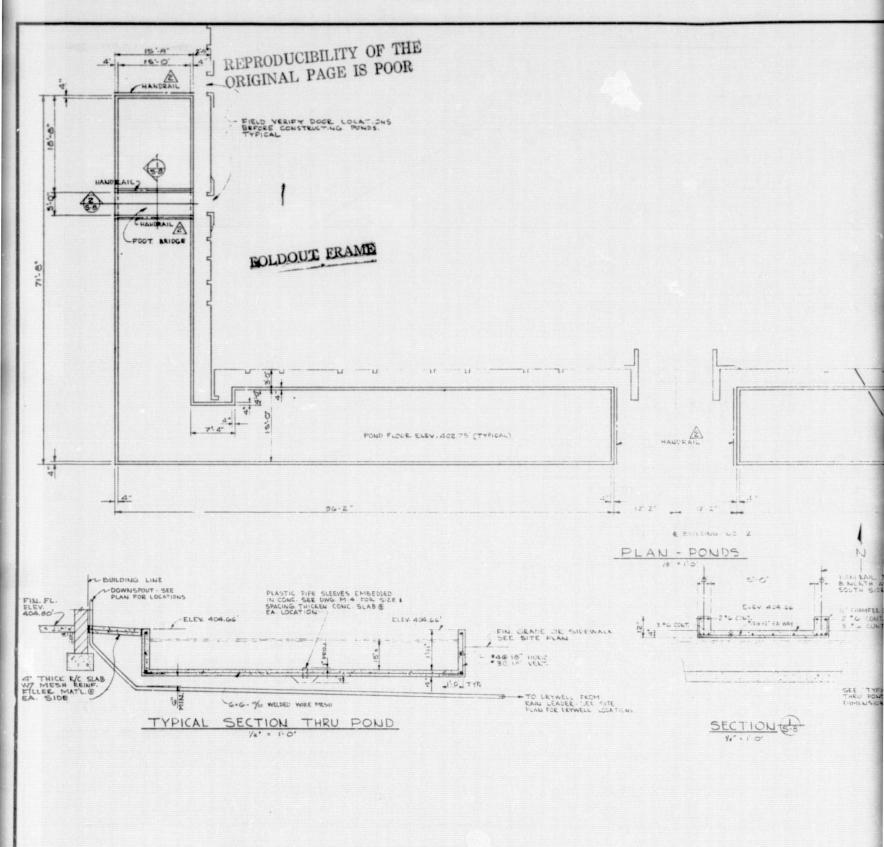
BRUNSTROM
MORGAN
PARTNERSHIP
ARCHITECTS & ENGINEER

1214 John Street Seattle, Wash. 98109 Phane: 462-4640

TE SIMPSON 6,251 HEAMING LHOKS TO TE STRINGERS TAILEL SUPPORT CANNO CETHER. TIC STAN WALL TO SEE 2-6 BOT HORD OF TO SIMPARLY

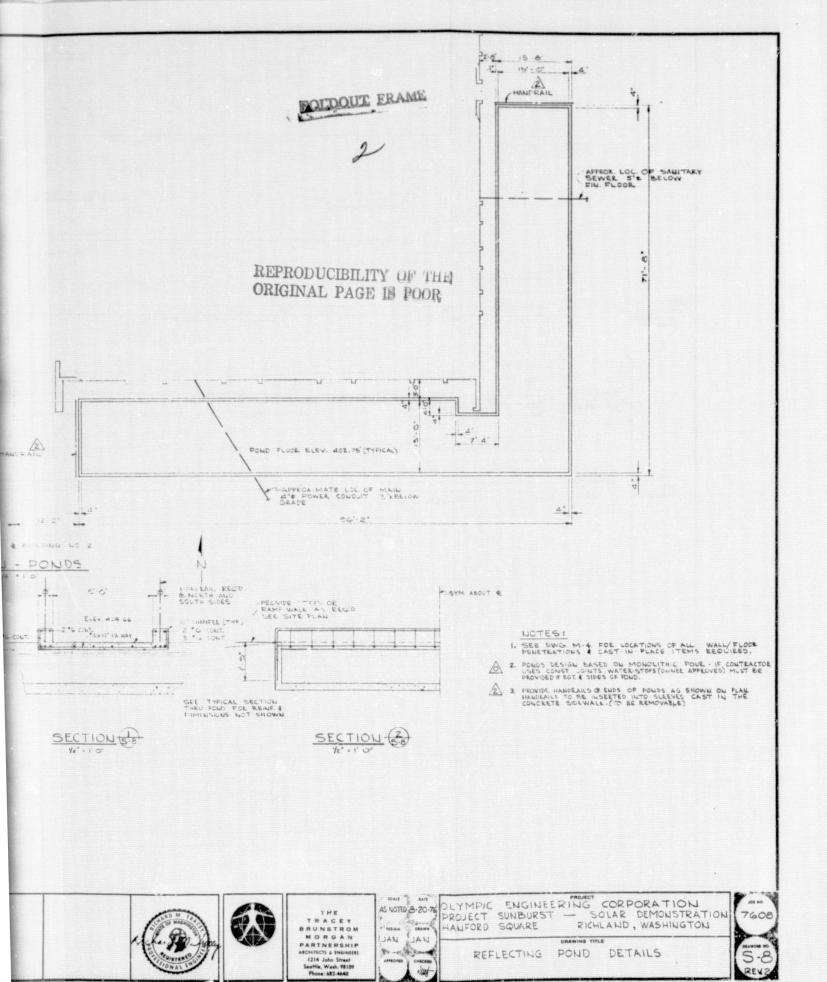
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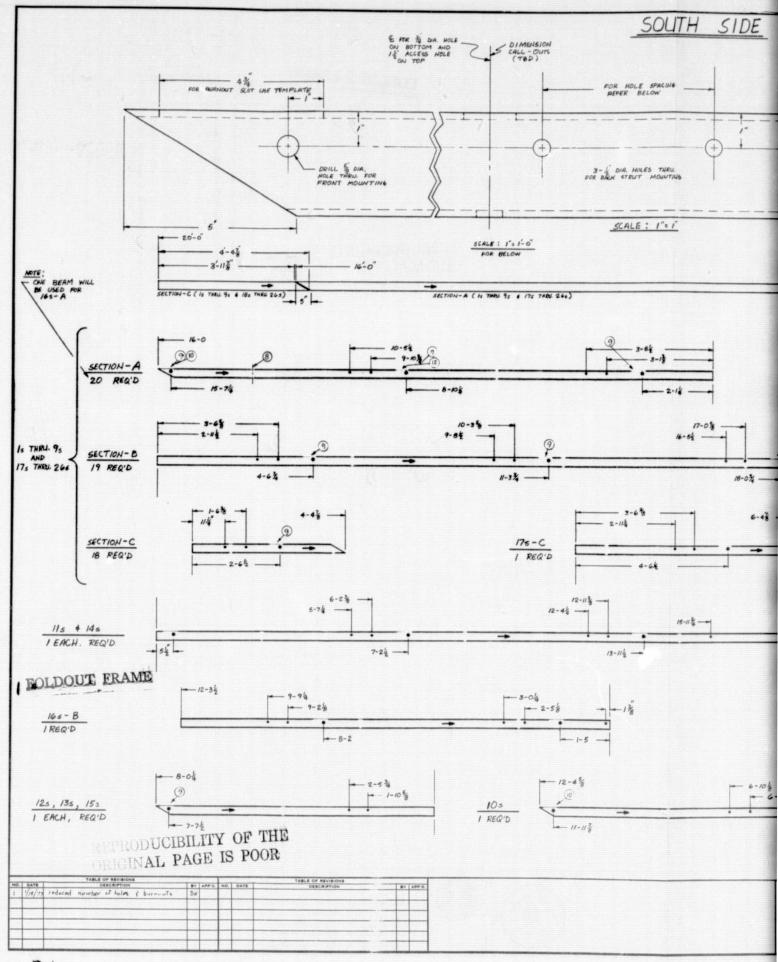
STAIR & SOLAR COLLECTOR TIE-DOWN DETAILS

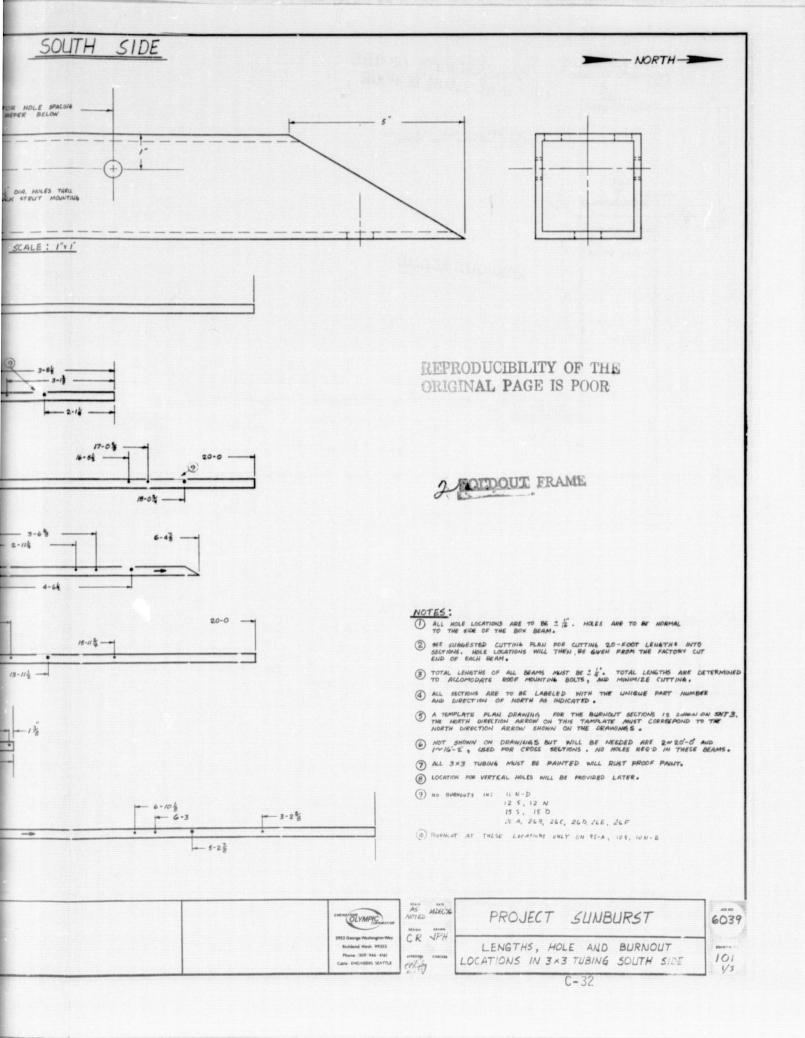


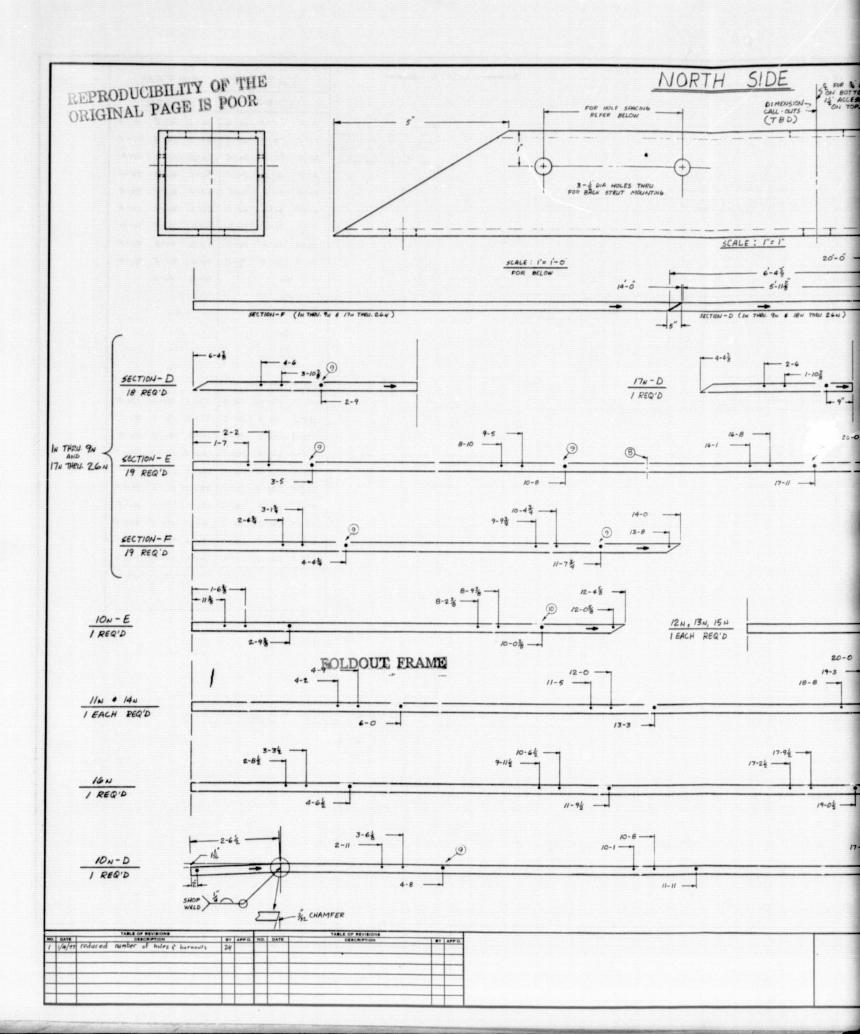
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0	8-20-76	ISSUED FOR POUD & FOOT BRIDGE	JAN	Ruet		
0	9-2-76	AND NOTE 2.	MAL	Put		
1	9.7.76	CHANGED POUD WALL F BASE SLAB THICKLESS	MAL	frut		
2	9-21-76	ADDED HOTE " 3 CHANGED POND DEPTH	UAL	WM.	md 14 "	

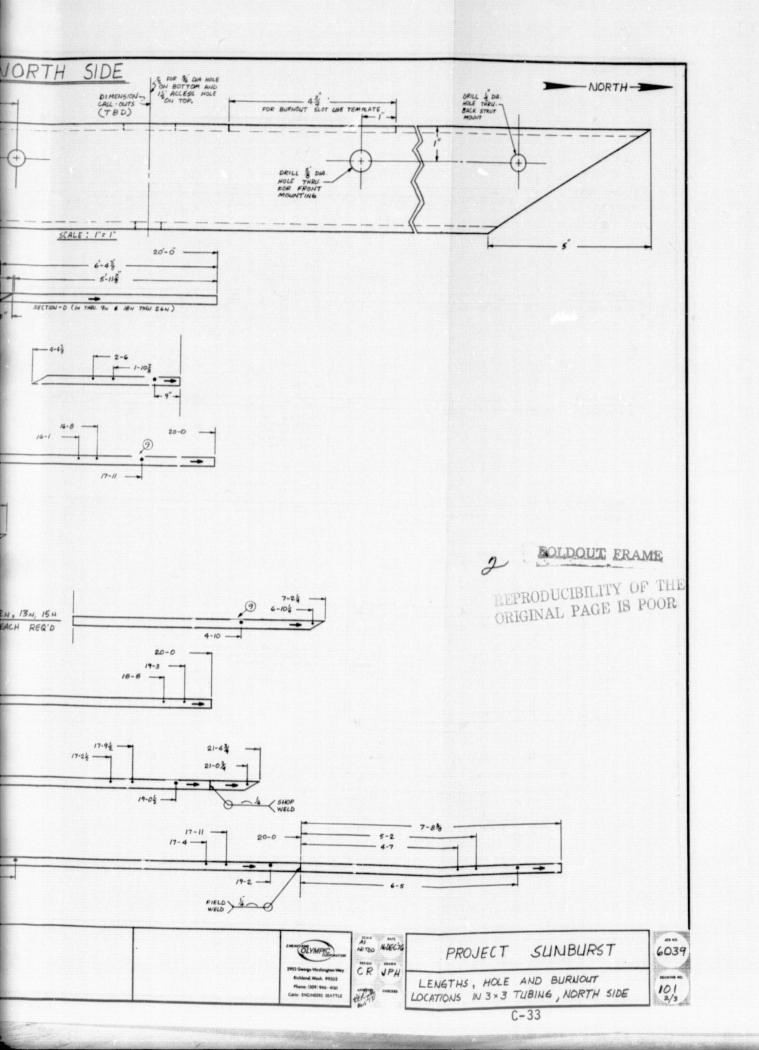


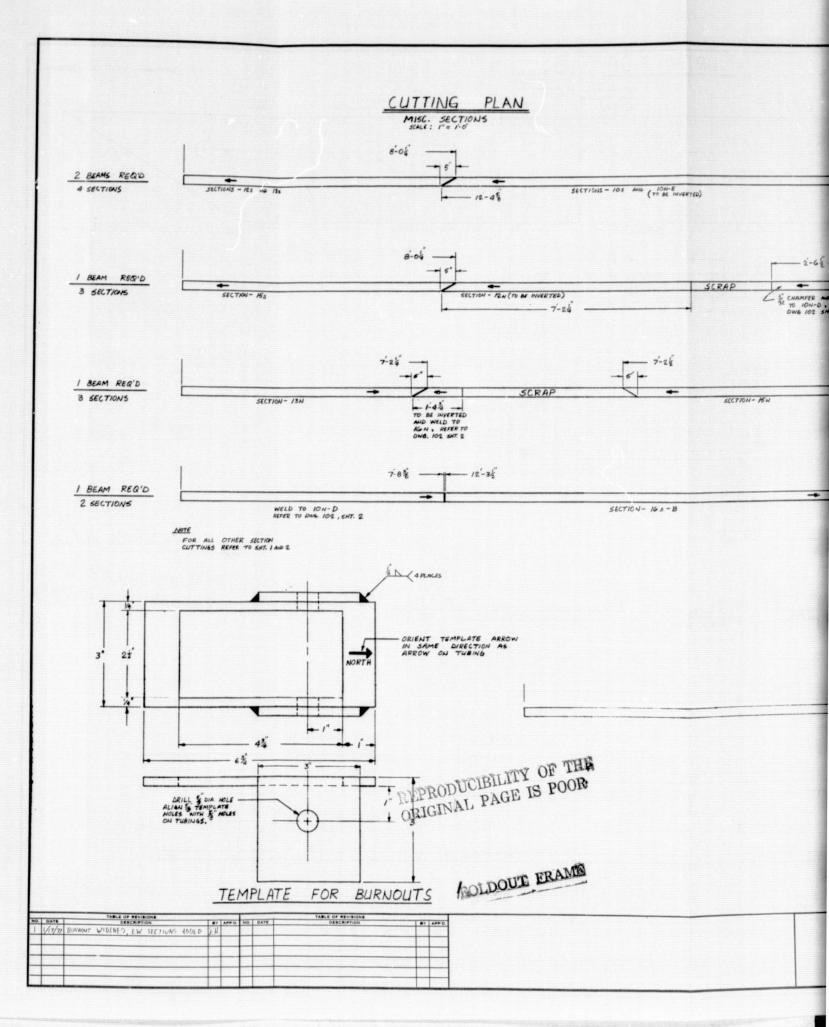


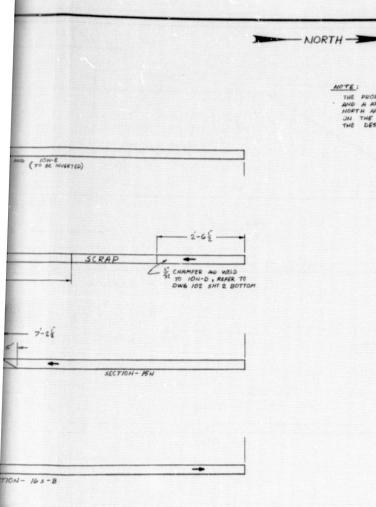




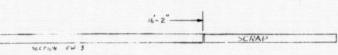








1-	L	LABELING SYSTEM								
	5	OUTH		NORTH						
ote:	Is-A	15-B	15-C	IN-D	IN-E	IN-F				
THE PROPER 1.D NUMBERS	25- A	25-8	25-C	2 H-D	24-E	2H-F				
NORTH ARE TO BE PLACE ON THE NORTH END OF THE DESIGNATED BEAMS.	35-A	35-B	36-C	3N-D	3×-E	34-F				
	45-A	45-B	45-6	4N-D	4N-E	44-F				
	5s-A	55-B	55-C	5N-D	5N-E	54- F				
	65-A	65-B	45-C	6H-D	6H-E	GH- F				
	75-A	7s-8	7s-C	7w-D	7N-E	7N- F				
	8s-A	85-B	8s-C	8n- D	8×-E	BN-F				
	95-A	95 - B	95-C	9N-D	9N-E	9N-F				
	1	05		ION-D	ION-E					
	1	Is			1/4					
	1	25			12 4					
	1	3s			34					
	1	41		14 N						
/	,	56		15 N						
	165-A	165-B			16 N					
	175-A	175-8	175-C	17N-D	17x- E	17×-F				
	185-A	18s-B	185-C	18N-D	184-E	18H-F				
	195-A	195-8	195-C	19N-D	19n-E	19N-F				
	205- A	205-B	205-C	20N-D	20N-E	20 N- F				
	215-A	2/s-B	215-0	21N-D	21N-E	21x-F				
	225-A	225-B	225-C	22 H-D	22 N-E	22×- F				
	23s-A	235- B	23s-C	23N-D	23×- E	23 <sub>N</sub> -F				
	24s-A	24s-B	245-C	24N-D	24H-E	24N-F				
	25s-A	255-8	25s-C	25N- D	25N-E	25N-F				
	265-A	26s-B	265-C	26 N-D	26N-E	26 N- F				
	EAST-	WEST	SECTIO	NS (NO	HOLES OR	BURNOUTS				
	EW-1		EW	1-2	EV	J-3 .				



Note: [W-1 4ND EW-2 the FIRE 20" LENGTHS

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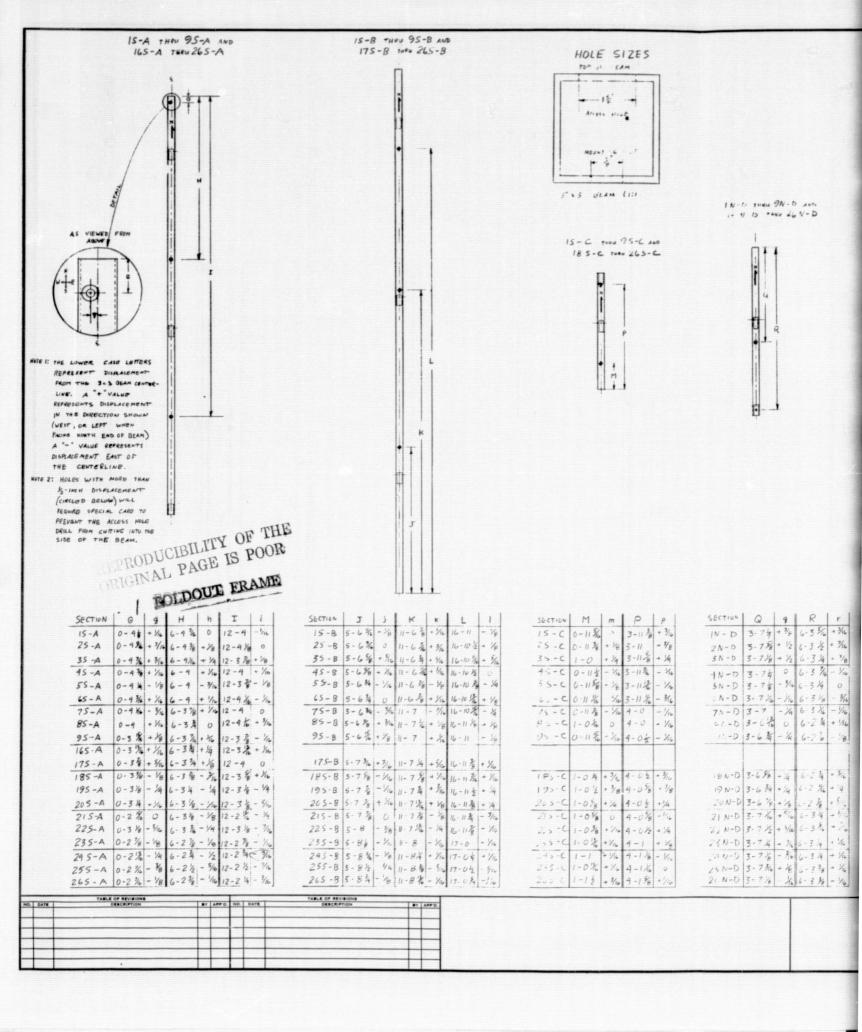
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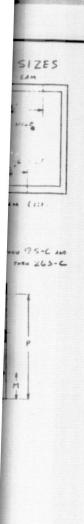
PROJECT SUNBURST

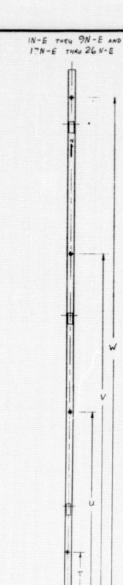
MISCELLANEOUS DRAWINGS

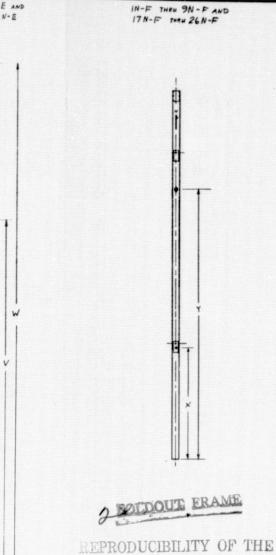
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3-112 - X 3-112 - X 4-0 - X	-11 % - 3/1 1-0 - 1/1 1-0 - 1/1 -0 / -
4-08 -3/8	-0 % + 3/8 -0 ½ + 1/4 -0 % - 1/6 -0 1/2 + 1/4 -1 + 1/4
	-0 % -1/6

SECTION	Q	9	R	r
IN-D			6-3 5/6	
2N-D			6-3 /2	
3 N - D	3-7/8	+ 1/2	6-34	+ 3/
1N-D	3-74	0	6-3 7/6	- 1/1
5N-D	3-75	- 3/16	6-34	0
: N - D			6-31/8	
7N-D	3-7	-1/4	6-3 1/6	-1/4
61D	3-6%	0	6-24	+ 1/1
7A-D	3-634	- 14	6-2 8	- 1/8
18N-D	3-6 %	+ 1/4	6-2 %	+ 3/4
			6-2 1/6	+ 4
			6-2%	+ 5.
			6-34	+ 3/1
27 N-D				+ 7
23N-D				+ 1/6
V1 10-0				+ 1/10
25 N-D	3-73%	+ 18	6-338	+ 1/6
2(-N-D	2-7%	1	1-22	- 1/6

1 N-D + HEA 9N-D AND

SECTION	T	t	U	u	V	v	W	w
IN-E	1-75	+3/8	6-11 %	+ 3/8	12-11 36	+14	18-11 %	+ 3/16
2 N - E	1-7%	+ 5/16	6-11 3/8	+ 3/8	12-11 76	+ 3/8	18-11 %	+ 1/8
3N-E	1-7省	+ 1/16	6-1134	+ 9/16	12-11 %	(+9/W)	18-113	+ 3/8
AN-E	1-7%	0	6-11 %	+ 1/8	12-11 3	0	18-111/6	- 1/16
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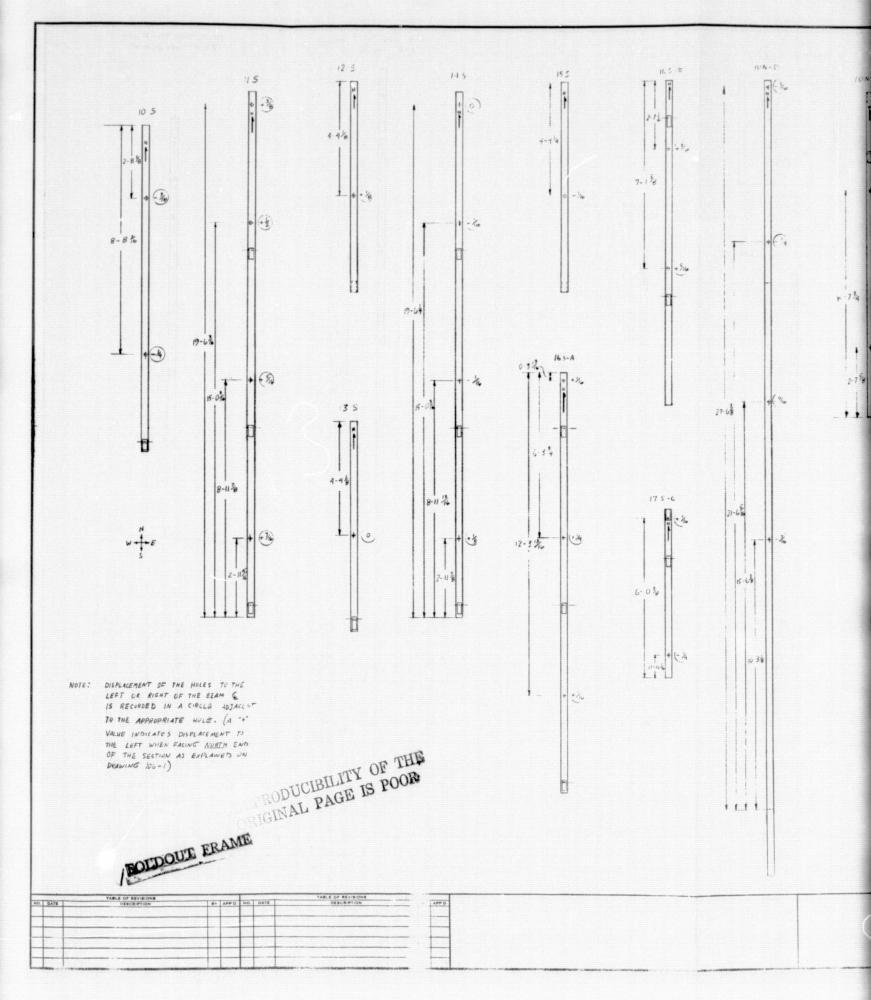


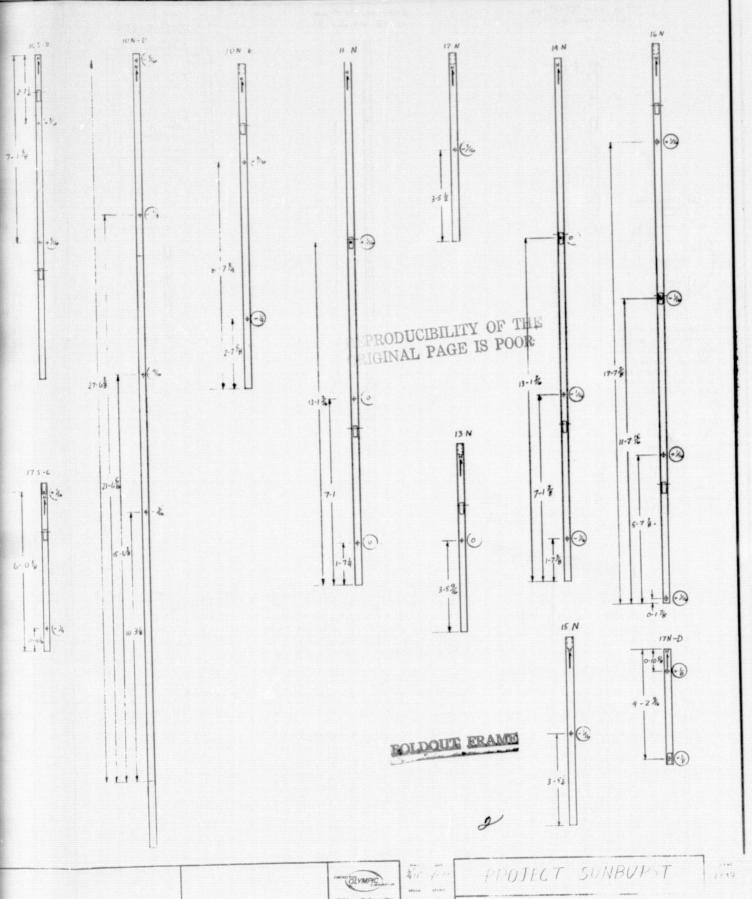




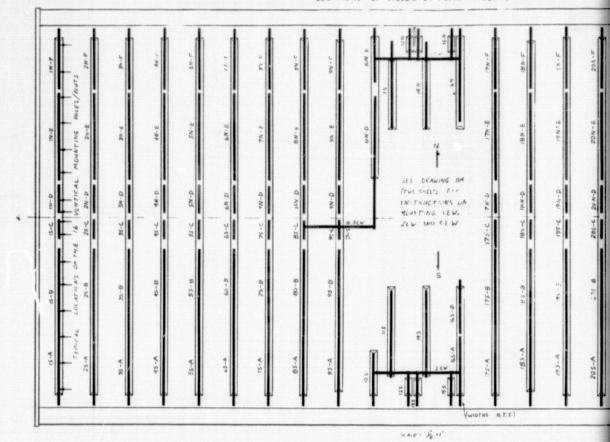
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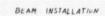


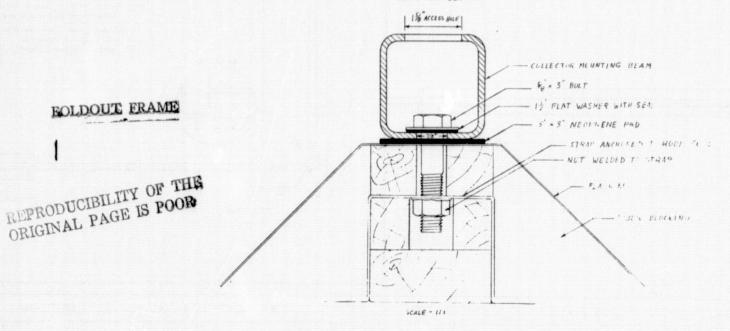




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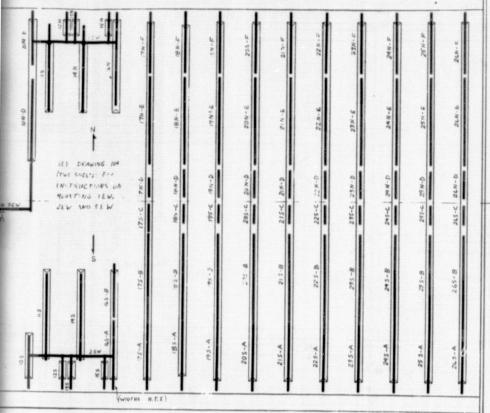






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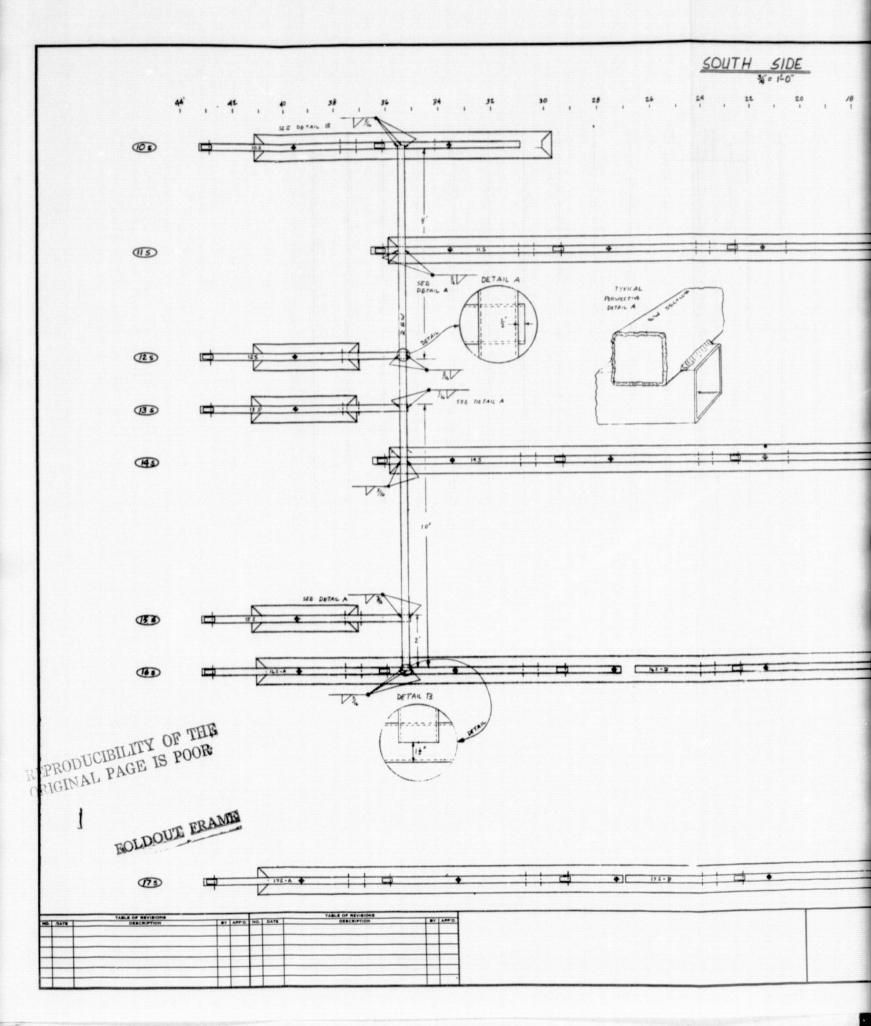


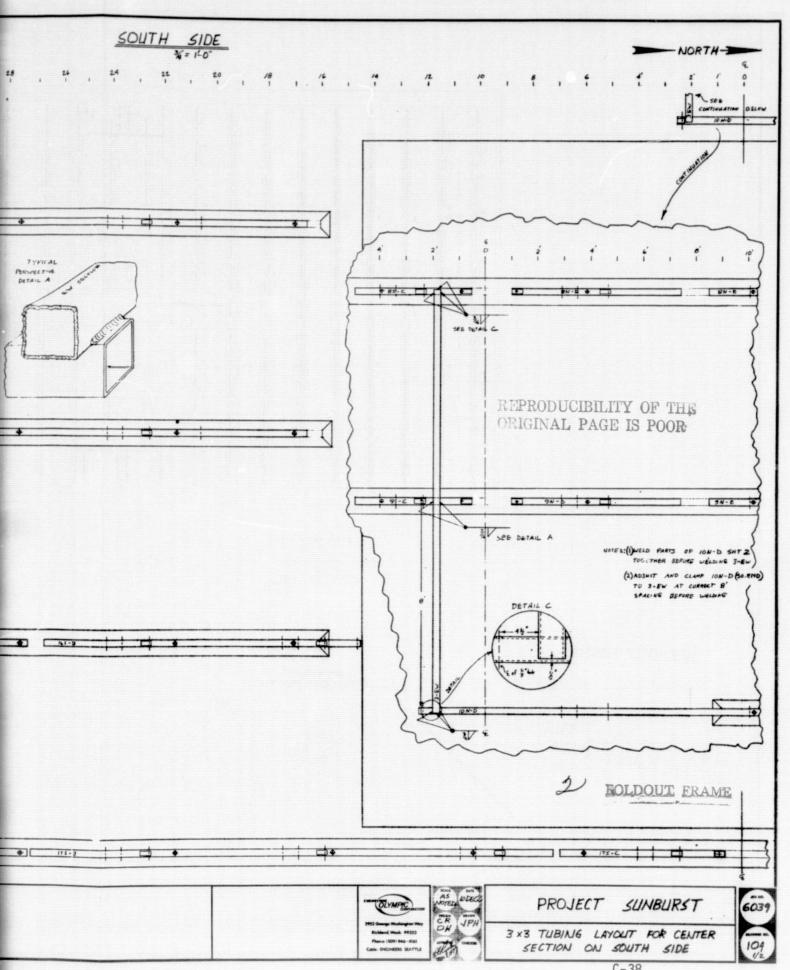
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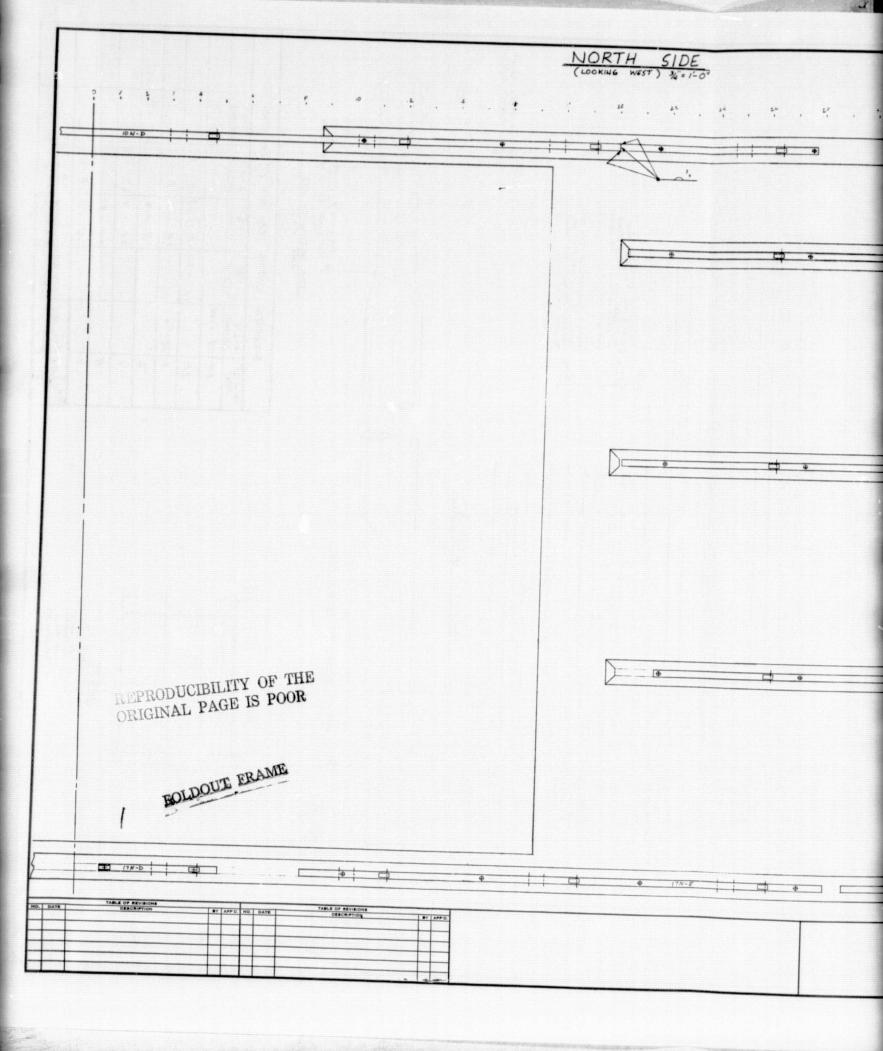
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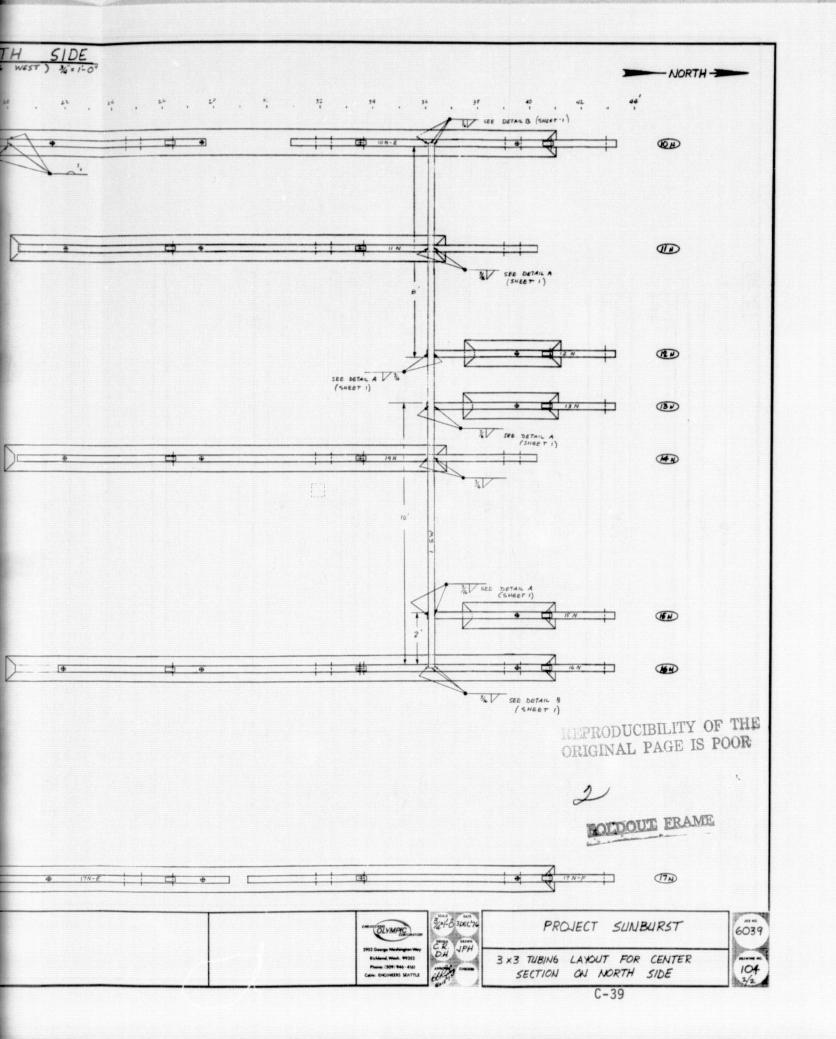


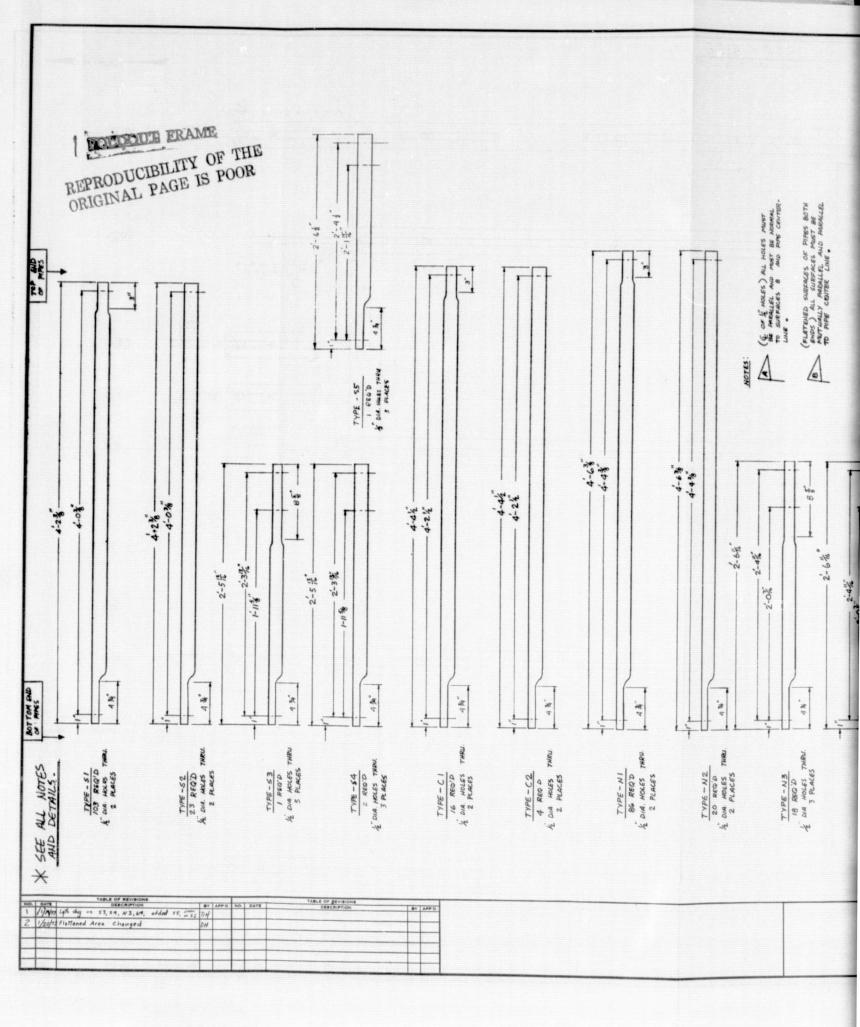
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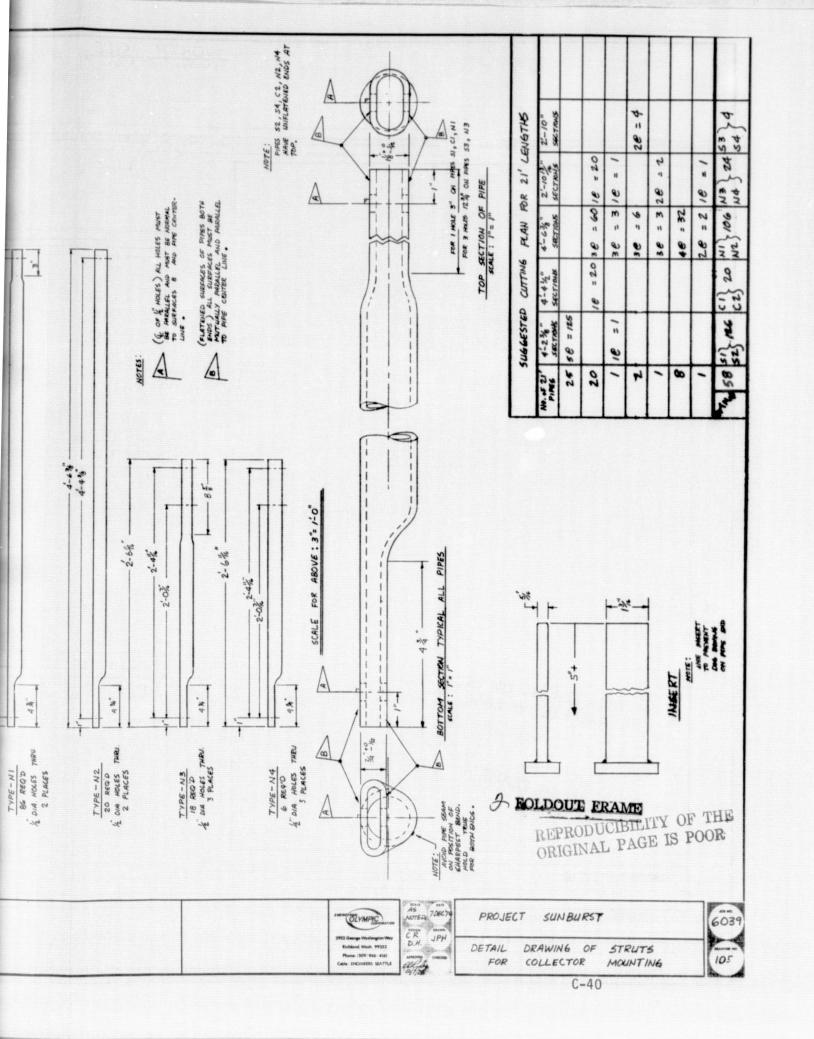










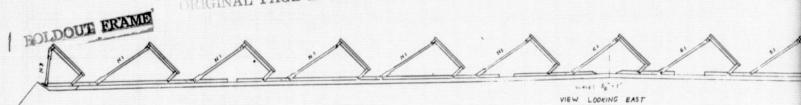


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L. THE VARIOUS STRUT TYPES ( 11, 52 ... ) ARE
SHOWN ON TRAWING 105
2. MOUNTING DETAILS ARE SHOWN ON DRAWING 107

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VIEW LOOKING EAST

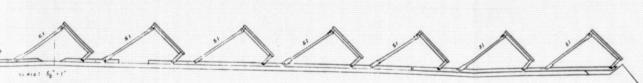
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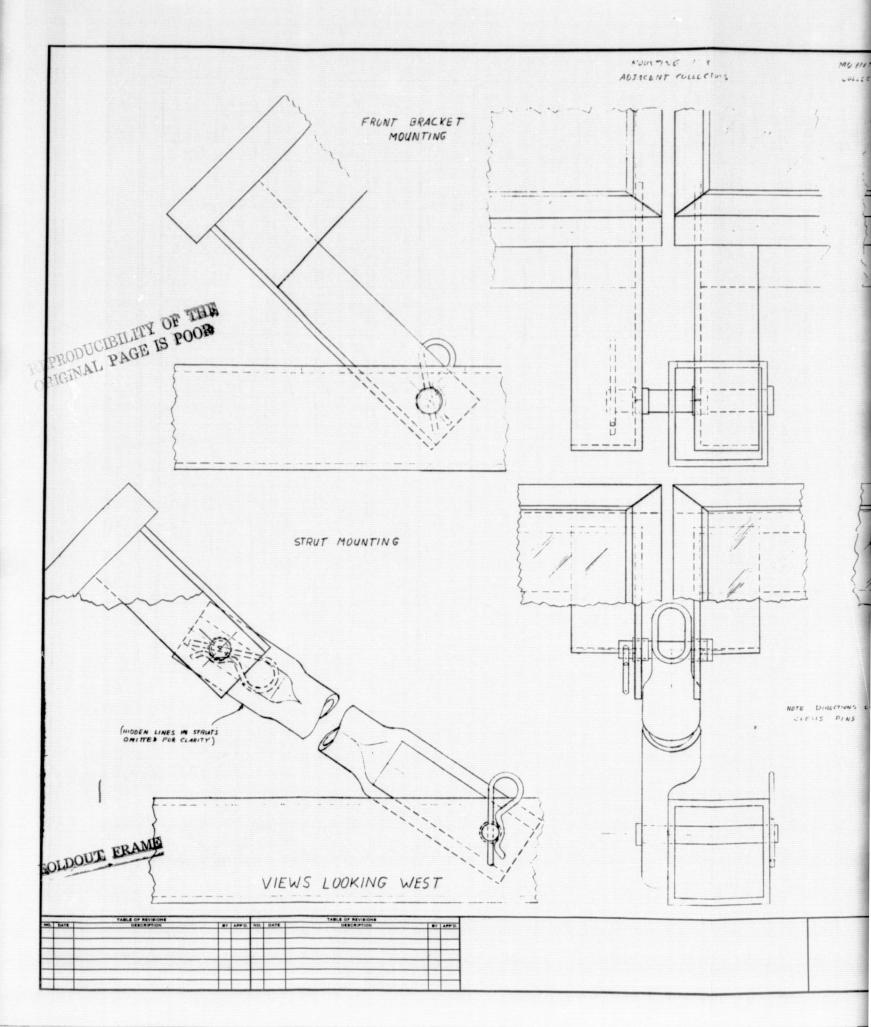


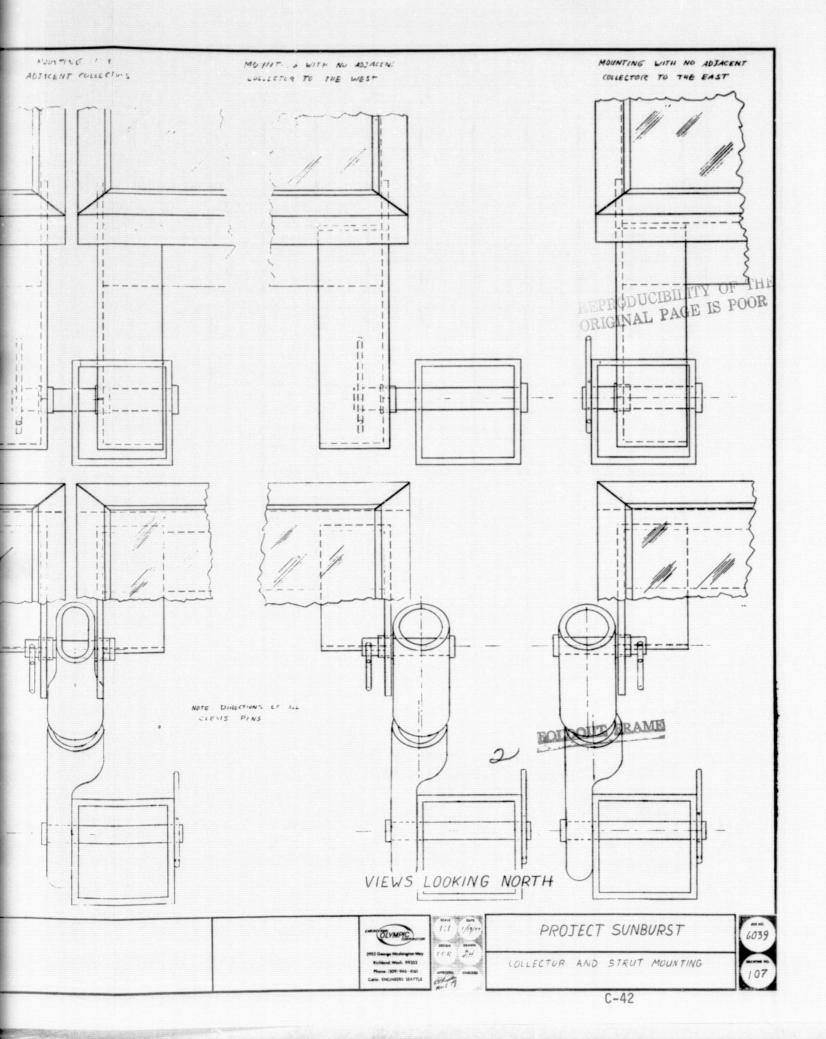
VIEW LOOKING EAST



PROJECT SUNBURST

LOCATIONS OF VARIOUS STRUT AND COLLECTUR TYPES





### APPENDIX D

PROJECT SUNBURST

PUBLIC RELATIONS PROGRAM EXHIBITS

### PROJECT SUNBURST PUBLIC RELATIONS PROGRAM EXHIBITS

One of the contractural commitments of Olympic Engineering was to encourage public exposure of the Sunburst project and to promote solar energy in general. Over the past 2-3 years Olympic has supported a public relations and education program centered around the Sunburst project. The selection of exhibits contained herein is by no means comprehensive, but is rather intended to illustrate the type of coverage provided by the press, the types of groups scheduling speeches on Project Sunburst, and the wide spectrum of people visiting the facility. A summary of the Project Sunburst public relations program is given in Section 2.4 of the Project Sunburst Final Report. This section provides selected exhibits from that public relations program. These are subdivided into the following sections:

	Page
Press Coverage	D-2
Public Speeches and Tours and Public Responses	D-28
Published Papers	D-47

### PRESS COVERAGE

Samples of press coverage of Project Sunburst are exhibited in this section. Items shown were selected mostly from those featuring exclusive coverage to Project Sunburst, and most of those not included contained references to the project but dealt with general topics, and/or were not a result of promotional efforts of the Olympic Engineering Corporation. Published papers are included in another section of this summary.

	Page
Sample Press Release	D-3
Initial Press Coverage	D-4-7
Ongoing Press Coverage	D-8-26
Periodical Coverage	D-27,28

(typical)

May 15, 1978 - FOR IMMEDIATE RELEASE

Charles C. Ripley will address the Washington Society of Professional Engineer's Solar Energy Seminar at the Governor House in Olympia, 4 PM, Friday afternoon, May 19. Ripley will discuss "Project Sunburst and Solar Energy in the Built Environment".

The solar energy seminar is sponsored by the Washington Society of Professional Engineers to provide interested engineers an understanding of the application of solar energy to meet heating and cooling needs in the Pacific Northwest.

Mr. Frank Welch of Olympia, a professional engineer and seminar registrar, said that the seminar will cover system design, cost effectiveness, available solar equipment, energy storage, tax incentives and climatological factors affecting solar utilization.

Mr. Ripley is a professional nuclear engineer and senior energy consultant for Olympic Engineering Corporation of Richland and is chairman of the Tri-City Nuclear Industrial Council's Residential Energy Savings Committee.

For More Information, call: Mr. Frank Welch, P.E.

telephone: (206) 753-3875

CC: Tri-City Herald Jim Outcost. bcc: PE Jobs

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KEPR TV TIM BOYD

KNDU TV MINE SCOTT ED E MANS

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KOTY Radio POSTY JONES

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# Tri-City Herald

Regional Voice of the Mid-Columbia Empire

COPY 15c

VOL. 68, NO. 82

Monday, April 5, 1976

Pasco, Kennewick, Richland, Washington

## Olympic Engineering gets grant for solar project

The Olympic Engineering Corp. of Richland has been awarded a \$500,000 grant to build a solar energy demonstration project north of town, federal officials announced today.

Dr. Robert Seamans, administrator of the Energy Research and Development Administration, said the award is the third largest of 34 projects costing some \$7.5 million.

The project will include two identical buildings built on Port of Benton property North of Richland. One building will be heated and cooled exclusively with solar power and the other will use conventional methods.

Charles Ripley, project manager for Olympic, said construction of the solar building is scheduled to begin in July with it operating before the end of the year.

The solar and conventional one-story buildings are for offices, Ripley said. The conventional building is built and the interior is being finished for occupancy, he said.

"We are enthusiastic about the potential energy source to meet the ERDA national energy program," Ripley said. "It's a unique opportunity for us in this energy conscious area."

Rep. Mike McCormack, D-Wash., said the project was chosen from among 308 proposals. Funds come from the Solar Heating and Cooling Demonstration Act of 1974.

Among the projects, will be 10 office buildings, five schools, three hotels or motels, two fire stations, two factories, one hospital, one laboratory one library and other structures, he said.

McCormack said the Richland project is for measuring the effectiveness of solar energy for heating and cooling Mid-Columbia latitudes.

The proposal was made jointly by Olympic Engineering, Development Dynamics Brunstrom-Morgan Partnership, all of Richland.

McCormack said he was pleased that 60 per cent of the projects will be small businesses and that 75 per cent of the solar equipment will be supplied by small manufacturers.

Such participation was the intent of the solar Heating and Cooling Demonstration law, he said.



### Regional/Local Digest

### Grant for Solar Project

A \$500,000 federal grant has been awarded to the Olympic Engineering Corp. of Richland to build a solar energy demonstration project north of the Eastern Washington city.

The project, financed by the U.S. Energy Research and Development Administration, will include two buildings on Port of Benton property, one to be heated and cooled exclusively with solar power, and the other with conventional methods. The plants are expected to be operational before the end of the year.

Spokane, Wash., Tuesday, April 6, 1976 THE SPOKESMAN-REVIEW

### SOLAR ENERGY

RICHLAND Wash, (AP)—The Olympic Engineering Corp. of Richland has been awarded a \$500,000 grant to build a solar energy demonstration project north of here, federal officials announced Monday

Dr. Robert Seamans, administrator of the Energy Research and Development Administration in Washington, D.C., said the award is the third largest of 34 projects totaling \$7.5 million.

The project will include two identical buildings constructed on Port of Benton property. One building will be heated and cooled exclusively with solar power and the other will use conventional methods.

Charles Ripley, project manager for Olympic, said construction of the solar building is scheduled to begin in July. It should be operational before the end of the year, he said.

Funds for the project come from the Solar Heating and Cooling Demonstration Act of 1974. The Richland project is designed to measure the effectiveness of solar energy for heating and cooling in mid-Columbia latitudes.

## City firm has solar-energy contract

By HILL WILLIAMS
Science Editor

A Seattle company has a federal contract to install and demonstrate a system to use the sun's energy to heat, cool and provide hot water for an office building in Richland.

Richland is one of the sunniest places in the Pacific Northwest. Its temperatures often range from more than 100 degrees in the summer to below 0 in the winter.

The Energy Research and Development Administration, which is increasing its research on solar energy, will provide about \$575,000 for the project, the third largest among 34 awards. It is the first such project in this area.

The Olympic Engineering Corp., Seattle, and its Richland subsidiary, Development Dynamics, will provide the building and necessary modifications for the solar equipment. The General Electric Co.'s space division will provide the solar equipment and the expertise.

THE BUILDING, 80-by-180-feet and one story high, also will have conventional heating and cooling equipment. But Olympic Engineering estimates that solar energy collected by 8.000 square feet of panels on the roof will provide about 55 per cent of the heating and 90 per cent of the hot-water requirements for the entire building and about 70 per cent of the cooling for half of the building.

The other half will be cooled by conventional equipment.

An almost identical building will be next door with conventional heating, cooling and water-heating systems. This will provide a comparison of energy use.

The conventional building is about 95 per cent completed, said Peter E. Jobs, executive vice president of Olympic Engineering. Construction of the solar-demonstration building is expected to begin next month and take about six months.

OLYMPIC ENGINEERING estimates the solar-energy system will add about \$318,000 to the \$794,000 cost of the building. Based on expected electrical rates, the company calculates it would take about 40 years to pay off the solar system in energy savings. The payoff would

power rates.

A mixture of water and ethelene glycol will be heated in tubes in the solar panels on the roof. The heated fluid will give up heat to water through a heat exchanger.

be quicker in areas with higher

In winter, the hot water will heat

the building much like a conventional hot-water system, except for the source of the energy. In summer, the energy from the sun's heat will be used to refrigerate water, which then will be pumped through the building for cooling.

THE BUILDING will have other energy-saving devices, such as window-slat blinds which can either absorb or reject the sun's heat and ponds south and west of the building that will reflect the sun's heat onto the walls during winter and be used as a heat sink, or heat dump, in the summer.

Development Dynamics will become the ultimate owner of the building after the mortgage is paid off. The appraised value of the completed project is about \$1.5 million.

The architect-engineer is the Tracey-Brunstrom-Morgan Partnership, linked to Olympic Engineering by common ownership. ORIGINAL PAGE IS POOR

The Seattle Times

Largest daily and Sunday circulation in Washington Wednesday, April 7, 1976

### In Richland

## Solar building planned

SEATTLE (AP)—A Seattle company will begin next month on the construction of an office building in Richland, which will use the sun's energy to heat, cool and provide it with hot water.

The project, to be undertaken by the Olympic Engineering Co. of Seattle and its Richland subsidiary, Development Dynamics, is the first of its kind in this area.

The Energy Research and Development Administration, which is increasing its research on solar energy, will provide about \$575,000 for the project, the third largest among 34 awards.

The building will have conventional heating and cooling equipment. But Olympic Engineering estimates that solar energy collected by 8,000 square feet of panels on

the roof will provide about 55 per cent of the heating and 90 per cent of the hot water requirements for the entire building.

It will also provide about 70 per cent of the cooling for half of the building. The other half will be cooled by conventional equipment.

An almost identical building will be built next door with conventional heating, cooling and water-heating systems, to provide a comparison of energy use.

The conventional building is about 85 per cent completed, said Peter E. Jobs, executive vice president of Olympic Engineering. Con-

struction of the solar demonstration building is expected to take about six months.

Olympic Engineering estimates the solar-energy system will add about \$318,000 to the \$794,000 cost of the building. Based on expected electrical rates, the company calculates it would take about 40 years to pay off the system in energy savings.

###



ARCHITECTURAL DRAWING of the Hanford Industrial Square showing the control building (left) which is about 95% complete, the solar demonstration building (lower right) scheduled for construction in May and the third building (upper right corner) not yet constructed. At the upper left is the site of the planned fourth building.

### Olympic Engineering wins solar building grant

Olympic Engineering Corp. building will be 80 by 100 ft. and of Seattle has been awarded a grant of about \$550,000 by the Energy Research & Development Administration for a solar demonstration building in Richland, Dr. Robert Seamans, ERDA administrator announced.

The grant is the third largest among 34 awards in 22 states and the Virgin Islands for the installation of solar heating and/or cooling sys-

The solar demonstration building will contain office spaces. It is part of a four - phased - development known as Hanford Industrial Square. Total cost of the development is estimated at \$1.5 million.

Olympic Engineering is the construction manager of the project, located at Battele Blvd. and George Washington Way, near the Hanford Reservation.

Peter E. Jobs, executive vice president of Olympic Engineering, said that a computer simulation was developed to determine the optimum overall program for the solar building.

The result, he adds, is that the flect the sun's heat. Ponds south

one story high and will be heated and cooled by solar energy collected by 8000 sf of panels on the roof.

The energy collected will provide about 50% of the heating, 90% of the hot water requirements and about 70% of cooling for half the building. The other half will be cooled by conventional equipment.

Adjacent to the demonstration building is an identical building which is about 95% complete. This building will be heated and cooled with conventional systems and will be the control building to which the solar demonstration building will be compared.

The roof of the demonstration building will support the solar panels which contain tubes with a mixture of water and ethylene gly-col. The fluid, when heated, will give up heat to the water through a heat exchanger. The heated water will then be stored below ground in an insulated tank and used when required either for heat-ing or cooling the building or as hot water in the plumbing system. In winter, the building will be

heated much like a conventional system except for the source of energy and, in the summer, the same energy will be used to refrigerate water which will be pumped through the building for cooling.

Other energy - saving devices, such as window-slat blinds, will re-

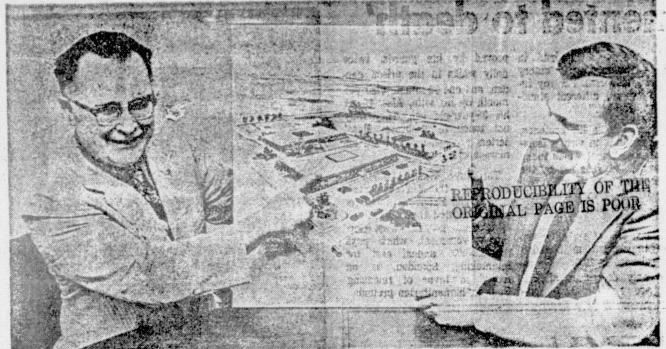
and west of the building will reflect the sun's heat onto the walls during the winter and will serve the dual purpose of use as a heat sink in summer.

us Rep. Mike McCormack, D-Wash., said the project was chosen from 308 proposals. The funds come from the Solar Heating & Cooling Demonstration Act of 1974. He said funds were allocated for 10 office buildings, five schools, one labora-tory, one library, and other structures.

McCormack said the Richland project is for measuring the effectiveness of solar energy for heating and cooling mid-Columbia latitudes.

Olympic Engineering Corp. will also provide construction cost control and scheduling, value engineering, construction claim analysis and energy research and development services.

Development Dynamics Co. of Richland is the owner of the project and is handling leasing arrangements. The Tracey, Brunstrom, Morgan Partnership, Seattle, is the architect. General Electric Co., acting through their Space Division, will provide solar equip-ment and support services. The George Grant Co. of Richland is the contractor for the first phase of the contract. Financing is through Columbia Federal Savings & Loan Assn., Yakima.



The solar building in Olympic Engineering Corp.'s Richland demonstration project was pointed out by Charles Ripley, left, project

manager, to Gerald Brunstrom, president. (Herald photo by Lon Martin)

### Solar projects planned in Richland

By JIM DALEN Berald Science Writer

The home of the atom soon will become the home of a solar energy demonstration project "unique in the United States," according to Gerald Brunstrom, president of Olympic Engineering Corp.

Twin office buildings, now under construction in north Richland, will make up a controlled scientific experiment in using sun power to heat and cool a commercial building, as well as supply the hot water.

The Energy Research and Development Administration (ERDA) which is increasing its research on solar energy, will provide about \$500,000 for the project, the third largest among 34 awards.

Olympic's project, selected from 308 entries will be the only one in the Pacific Northwest.

"We were already underway on Hanford Industrial Square when the invitation came out for commercial solar cooling and heating proposals," said Brunstrom.

"It seemed like a 'natural' for this part of Washington."

Located on Port of Benton property north of the Washington Public Power Supply System, the demonstration building, to be occupied by Olympic, will have conventional heating and cooling equipment.

But solar energy collected by 8,000 square feet of panels on the roof will provide an estimated 55 per cent of the heating and 90 per cent of the hot water requirements for the entire building.

It also will supply about 70 per cent of the cooling for half the building.

Next door, an almost identical 14,000-square-foot single-story structure nearing completion, will be heated and cooled conventionally with electrically powered heat pumps, to provide a comparison of energy use.

Another firm will use that building for offices and laboratories.

Charles Ripley, Olympic's Richland, research and development manager, said the solar equipment will be installed about July when the building is completed. It should be in operation next winter.

The initial testing period is for two years to gain performance data, with an option of government sponsorship for five years longer to test modifications and make improvements on the system.

"We expect to go on from there and assist others in gaining benefits from our solar research and technology," said Ripley. "The advantages of solar will become more and more important as the cost of electrical energy from fossil and nuclear sources goes up," he noted.

Ripley's no newcomer to the field. Back in 1963 he installed a solar system in his San Jose, Calif., home to heat the family swimming pool.

He said there'll be little discernible difference in the appearance of the two building.

The solar building will have shiny plastic collector plates on the roof. Decorative ponds on the south and west will reflect the sun's heat onto the walls during winter and be used as a heat pump in summer.

Special venetian blinds can be adjusted either to absorb or to reject the sun's heat. Outside, an "energy speedometer" will tick off kilowatt hours saved on a digital sign for passersby on George Washington Way. Dollar savings on electric bills will be returned to the government each year, Ripley said.

Olympic estimates the solar

energy system will add about \$318,000 to the \$794,000 cost of the building. Based on expected electrical rates, officials calculate it would take about 40 years to pay off the system in energy savings.

The company, based in Seattle, opened a Richland office in 1971 to assist in construction planning and scheduling for the High Tem-

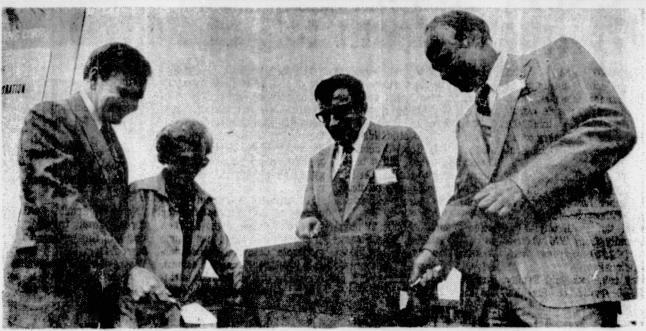
perature Sodium Facility at Westinghouse Hanford Co.

Olympic employs 130 persons, 65 of them in Richland.

Brunstrom said, "We're very excited about the future of this area as the setting for research and demonstration of all forms of energy sources.

"We're limited only by our imagination," he said.

D-10



Gerry Brunstom, Olympic Engineering president, state Rep. Pat Cochrane, D-Richland; Rep. Mike McCormack, D-Wash, and Architect Richard

Tracy helped lay the cornerstone for the solar energy project Friday afternoon.

## Solar energy project gets off ground

Richland's federally funded solar energy project literally got off the ground Friday with a cornerstone-laying ceremony.

Olympic Engineering of Richland had received a \$500,000 grant from the Energy Research and Development Administration for the project scheduled for completion by December.

Twin office buildings will make up a controlled scientific experiment in using sun power to heat and cool a commercial building as well as supply the hot water.

Located on Port of Benton property north of the Washington Public Power Supply System, the demonstration building, to be occupied by Olympic, will

have conventional heating and cooling equipment as back-up for the solar gear

for the solar gear.

The solar building will also have a public reception area for viewing the system in operation as part of Olympic's offices.

Next door, an almost iden-

tical 14,000 square foot single story structure will be heated and cooled conventionally with electrically powered heat pumps to provide a comparison of energy use.

The Tracey-Brunstom-Morgan firm of Seattle is the architect on the project and General Electric Co., through their space division, will provide the solar equipment.

The George A. Grant Co. of Richland is the general contractor with financing supplied by the Columbia Federal Savings and Loan Association of Wenatchee.

## Office building to demonstrate solar energy

By PAT MOSER Herald Staff Writer

If you're looking for a way to cut your heating and air conditioning bills, drop by the Olympic Engineering Corp. in Richland for some pointers.

Its solar heating and cooling office building will be finished in January.

But if you can't wait that long, see H.E. Mackenstadt, 811 W. 23rd Place, Kennewick.

You can't miss his home. It's the one with the eight black squares on the garage roof.

In back, Mackenstadt is swimming in his pool heated by the sun shining on those black squares, through which the pool water is filtered.

First of all, he'll tell you he's saving \$100 this year on his gas bill. Before he spent \$1,000 on his solar system pool, heating cost him \$150 a year.

Charles C. Ripley, Olympic's energy research and development manager in Richland, told the Pasco-Kennwick Rotary Club Wednesday about his firm's demonstration of solar cooling and heating in its Richland office building under construction.

The Energy Research and Development Administration will provide \$500,000 for the project, which will compare the demonstration of fice building energy consumption and costs with an exact replica nearby using conventional cooling and heating systems.

But few Rotarians will be constructing 14,000 square foot buildings with 8,000 square feet of sunlight collectors like Olympic.

"But you can save on your energy costs using solar methods," Ripley told them.

And Mackenstadt after the meeting told Ripley how he saved two thirds in his pool heating bill.

Ripley showed a venetian blind, available now, which will reflect heat on hot days with its shiny surface and by pulling a cord you can collect heat on the blind's black reverse sides on cold days.

There also are vertical drapes with light and dark sides to do the same thing, Ripley said.

"Any savings you do is good no matter whether you're paying 1 cent a kilowatt here or 7 or 8 cents on Long Island," Ripley said, adding that together it amounts to barrels of oil that won't be consumed.

The Olympic solar building will have a 9,000 gallon storage tank to store the ethylene glycol-water solution similar to anti-freeze that is heated to 210 degrees at the collectors on the roof.

It's enough storage to last the building through three sun-less days, he said. If there're more sun-less days, a conventional system will take over. The heat from the reservoir will be pumped into an "absorption chiller" causing the freon liquid to expand. The expansion, cools the liquid. The system is similar to the old refrigerators which had the cooling coils on top, Ripley said.

Mackenstadt's 21,000-gallon swimming pool also can work as a reservoir for heat, Ripley said.

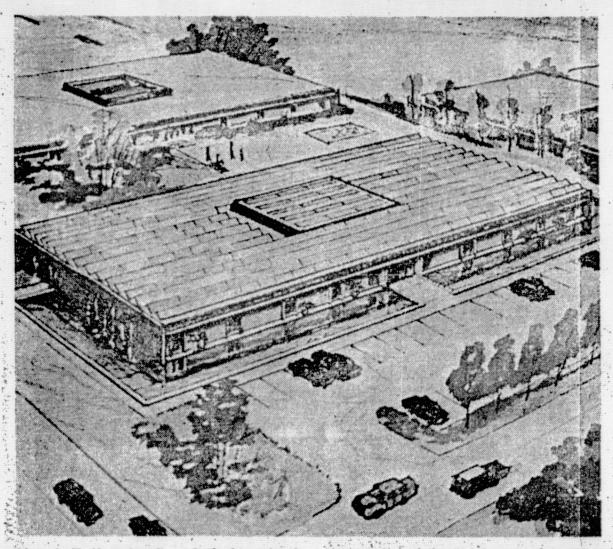
By covering the pool in the winter, as some do with plastic domes, Mackenstadt could pump the warm water to his home where heat exchangers would force it throughout.

Ripley said that solar heating systems are best when they are installed as a house is built.

"If you're building you should have a solar system as part of your specifications," he said. "It can be done today."

Olympic will have a visitors' room at its solar building, which will show how the demonstration project works.

## Solar heat tested in



The Olympic Engineering Corp. built this twin office building complex (sketched, above) in North Richland that uses sun power to heat and cool a commercial building, as well as supply the hot water. One of the 14,000-square-foot structures is heated conventionally. The other, with solar panels supplying 72 per cent of the heating and 90 per cent of the hot-water requirements.

Some of the Washington Public Power System (WPPSS) staff are working in a building heated by the sun.

It's part of a twin-building solar demonstration project built by Olympic Engineering Corp. in North Richland.

Battelle-Northwest Laboratories occupies the conventional office building; WPPSS three-quarters of the solarbuilding, and the energy research and development section of Olympic, the rest.

Olympic also will use a third

office building being added to the complex.

Fountains and landscaping will be installed when the weather warms.

Work was slowed when plumbers struck last summer, said Olympic's Charles Ripley, the research and development manager who is in charge of the building project.

The demonstration building, with 252 roof-mounted solar collectors, has about 14,000 square feet of space. A similar one without collectors,

uses conventional heating.

The Energy Research and Development Administration (ERDA) wants to know how much in dollars and kilowatts can be saved by using the sun as a source of energy as much as possible in a large office building, officials say. Data from the demonstration office building will be compared with that from the conventionally heated building.

The supply service will share the sun-powered building with the energy, research

continued

## twin Richland buildings



Solar collecters installed on Olympic Engineering Corp.'s demonstration building in Richland were inspected by Dr. Robert Allen, senior scientist, and Robert Poplin, project engineer. Olympic received

a \$553,000 Energy Research and Development Administration grant to install a solar heating and cooling demonstration system in the new office building.

and development section of Olympic.

Olympic's proposal was selected and approved by ERDA from 308 around the country. The solar-powered office building in Richland will be the only one of its size and magnitude in the Pacific Northwest.

Solar energy collected by about 6,000 square feet of panels on the roof will provide about 72 per cent of the building's heating requirements and nearly 100 per cent of its hot water needs, said

Ripley

It also will supply about 97
per cent of the cooling for
the building, according to

Ripley and Gerald Brunstrom, Olympic's president.

The initial testing period is for two years, with an option of government sponsorship for five more years to test modifications and make improvements on the system.

Olympic won an 'nitial \$53,000 from ERDA for the

There is little difference in the appearance of the two buildings.

The solar building has shiny plastic collector plates mounted on the roof, with decorative ponds on the south and west which reflect the sun's heat onto the walls during winter and serving as a heat sink in summer.

"Outside, a digital "energy speedometer" will tick off kilowatt hours saved.

Before the summer strike, Olympic estimated the solar energy system would add about \$318,000 to the \$794,000 cost of the building.

## Sun to heat, cool Hanford

By JINI DALEN

Herald Science Writer

Olympic Engineering Corp. is preparing to "switch on the sun" to heat and cool its building in Hanford Industrial Square in North Richland.

The solar system now being installed is expected to be tested in late June and be operational by mid-July, said Charles Ripley, Olympic's research and development manager.

"We consider this a practical example of the classic scientifically controlled experiment," he said.

The solar building at 3070 Géorge Washington Way, oc-

cupied by Olympic's research and development department and the Washington Public Power Supply System, will receive 97 per cent of its air conditioning and 72 per cent of its heating from the sun.

Ninety per cent of its hot water also will be solar-heated.

An identical 14,000-squarefoot building next door, occupied by Battelle-Northwest Laboratories, is heated and cooled by a conventional electric heat pump.

"When heating costs are compared over a five-year test period, we will have a real life example of the actual savings that can be made using solar energy," Ripley noted.

The experiment is financed by a \$633,000 grant from the Energy Research and Development Administration.

After testing is completed in July, the solar building will be open to the public for scheduled tours, to include an exhibition hall and inspection of the entire solar system with real-time instrumentation.

Tourists will be able to climb to the roof to see and feel the 6,000-square-foot array of 252 solar collectors and to the basement to observe the solar energy and control system.

Heat from the sun is distributed through tubes containing ethylene glycol and water.

Each passage through the solar collector array heats the fluid 16 degrees F. The heated liquid then goes to a heat exchanger in the solar basement, and is transferred to city water in a 9,000-gallon insulated thermal energy storage tank buried under the sidewalk outside the basement.

Upon call by thermostats in the building, water more than 130 degrees F. is pumped to heating coils in the building's air distribution system.

During the summer, when the thermostats call for air conditioning, hot water is pumped from the thermal energy storage tank to a 25-ton absorption chiller, which cools the water from 55 to 45 degrees — at a rate of 2,000 gallons a half-hour.

That chilled water is pumped to overhead cooling coils, which chill the air in the building's distribution system.

The solar buildings, in use for the past several months, is now operating on its back-up heating and cooling system with electrically-driven heat numbs.

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ORIGINAL PAGE IS POOR

Tri-City Herald

MONDAY, APRIL 11, 1977

SECOND PAGE ONE

(continued)

## building



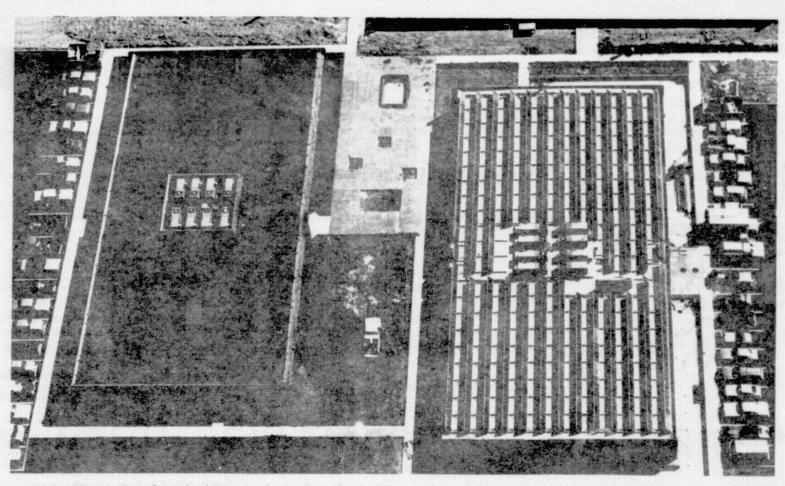
Fitter Don Goulet, Pasco, connected ethylene glycol-water distribution tubes to flat plate solar collector panels on the roof of Olympic

Engineering Corp.'s solar building in North Richland among 6,000 square feet of panels. (Herald photo by Lon Martin)

# hanford mews

serving the Hanford family

June 10, 1977



THIS AERIAL VIEW of Hanford Square shows the solar building in the right foreground, the control building in the left foreground (one additional office building in the complex is not shown). Long panels of solar collectors can be seen on the roof of the solar building. The cooling ponds, visible to the right of the building, will serve as a heat dump during summer and will reflect the sun's heat onto the walls during winter. (Photo by Photografix)

continued

RODUCIBILITY OF THE

## Project Sunburst --Solar energy gets cookin' at Hanford Square

Solar energy in the Tri-Cities is really starting to cook with the occupancy of two special buildings in North Richland's Hanford Square.

With the assistance of a \$667,000 grant from ERDA, Olympic Engineering Corporation, a Seattle-based firm is completing installation of a solar heating and cooling system on its new "Project Sunburst" building. An identical, conventional building next door will serve as a control for the demonstration.

The solar equipment for Project Sunburst will provide about 72 percent of the heating, 97 percent of the cooling, and virtually all of the hot water requirements for the one-story, 80-by-180 foot building. There is a backup electric heat pump heating cooling system. The control building has only an electric heat pump system.

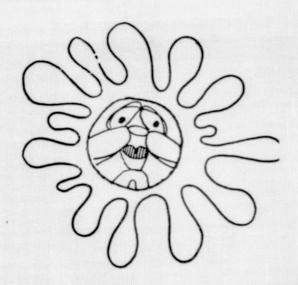
In addition to the energy conservation value, it is expected that the solar energy equipment may pay for itself in about 20 years.

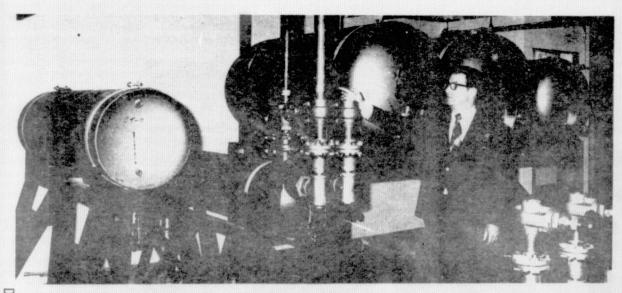
Some 150 Battelle-Northwest, Washington Public Power Supply System and Olympic Engineering employees are being housed in the two buildings.

The grand opening for Project Sunburst is planned for late July.



SOLAR COLLECTORS are the key in capturing the sun's rays for use at Project Sunburst. At left, Charles Ripley, Manager of Olympic Engineering's Energy Research and Development Department, Richland Division, shows a cutaway of a solar collector to Dianne Jackson. When in place, the collectors are backed by foam insulation and are capable of absorbing about 94 percent of available heat. An ethylene glycol and water coolant is pumped through the collectors, where it is heated to as high as 230 degrees Fahrenheit. About 126 gallons per minute pass through the collector system.





IN THE BASEMENT of the solar building, Dr. Emmett Moore, general manager of Olympic Engineering's Richland Division, points out pipe leading into the main heat exchanger. Coolant heated by the solar panels tlows through this exchanger, transferring heat to the 9,000 gallon thermal energy storage tank. Visible behind Dr. Moore are three large "expansion tanks." Since the solar heating/cooling system operates under a small amount of pressure, with liquid levels fluctuating at times, these tanks are necessary to accommodate excess volume.

Also located in the building basement is the "solar chiller." This apparatus acts as a refrigerator for a 2,000 gallon cold water storage tank, part of the building's cooling system. Energy to run this chiller comes from the heat of the solar panels. Pumps, valving, and electrical controls are other vital parts of the heating/cooling system located in the basement.

PAGE IS POOR



LATE IN 1976, this huge 9,000 gallon thermal energy storage tank was lowered into place at the Project Sunburst solar building. The tank stores hot water heated by the solar panels. Heat retention is sufficient to carry the building for three days without sunlight.

Below, Barbara Anthony and Chet Ryer take a closer look at one of the collector panels on the roof of the solar building. There are 252 collectors in all, covering roughly 6,000 square feet of space. Each collector measures 36 by 96 inches and weighs 80 pounds. Made of aluminum, the collectors will last up to 20 years.



Atlantic Richfield Hanford Company Federal Building Richland, Washington 99352 Telephone 509 942-7411 BARBACA ANTHONY
E.B. MOURE, SR
GRB

May 31, 1977

Mr. Chuck Ripley
Olympic Engineering Corporation
2952 George Washington Way
Richland, Washington 99352

REPRODUCIBILITY OF THE

Dear Mr. Ripley:

We understand that Olympic Engineering has asked to reprint for its own use, and at its own expense, the 2-page spread on Project Sunburst that will appear in the June 10 Hanford News. We have no objection to having additional copies made after the Hanford News has been published.

We can provide the press-ready copy used for printing the Hanford News, but expect Olympic Engineering to make all other arrangements for printing.

Very truly yours,

H. B. Lindberg - Manager

Communications and Public Affairs

HBL:abj

# Ari-City Herald

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MONDAY, FEBRUARY 13, 1978

SECOND PAGE ONE

# Solar energy project operating in Richland

By TODD CROWELL Herald Staff Writer

Richland entered the solar age this weekend when a demonstration project along George Washington Way began operating on solar power.

Olympic Engineering Co.'s "Operation Sunburst" actually passed two milestones this weekend, said Charles Ripley, project manager.

Thursday was the first day that Olympic's solar building in north Richland was heated by solar energy, and Friday was the first time it was heated by stored solar energy, Ripley said.

The solar collectors, installed as part of a \$700,000 federal demonstration project, have been waiting for nine weeks for enough sunlight to begin working.

Thursday was the first day in more than two months of almost unbroken overcast that there was enough sunlight to operate the system, Ripley said.

Enough power was stored that day to heat the building Friday, even though the collectors were frosted over Friday morning, Ripley said.

Olympic has a 9,000 gallon water tank which can store enough heat to heat the building for three days without sunlight, Ripley said.

For longer periods without sun, Olympic must rely on its backup electrical heating system that can provide 100 percent of the building's heating and cooling needs.

Ripley said it was a happy coincidence that the solar system began operating the day Rep. Mike McCormack D- Wash., was in Richland, so he could report the success personally to the congressman.

McCormack sponsored the Solar Community Heating and Cooling Demonstration Act under which the Olympic project is funded.

While in Richland, McCormack announced he and two colleagues, Reps. Olin Teague, D-Texas, and Barry Goldwater Jr., R-Calif., were introducing legislation to advance solar technology.

The bill provides for a 10year \$1.5 billion research and demonstration program in solar batteries to convert sunlight directly into electric energy.

"Our goal is to double U.S. production in 10 years and to be producing two million kilowatts of electricity by 1987," McCormack said.

## PRODUCIBILITY OF THE

Thursday, April 27, 1978

TRI-CITY HERALD, PASCO, KENNEWICK, RICHLAND, WASHINGTON

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## Solar energy project to be dedicated

The public is invited to the dedication of the Project Sunburst, a solar energy facility, at 2 p.m. Saturday at Olympic Engineering, 3070 George Washington Way, Richland.

Rep. Mike McCormack, D-Wash., will speak at the dedication.

Tours of the project, which is the largest commercial demonstration facility in the country for the Department of Energy, will be held from 2:45 to 5 p.m. Saturday.

McCormack sponsored the Solar Community Heating and Cooling Demonstration Act under which Project Sunburst is funded.

Solar energy provides 71 percent of the heating, 97 percent of the cooling and over 90 percent of the hot water for the Project Sunburst building.

Also scheduled to attend the dedication are Peter E. Jobs, executive vice president and managing partner of Olympic Engineering, state legislators, local government officials and representatives from firms working at the Hanford Project.

# hanford mews

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Richland, Washington • Friday, June 9, 1978 • Volume 14, Number 6

### Sun Day called 'radiant success'

The week of April 29 through May 6 was observed with a variety of activities in Richland emphasizing the potential of solar energy. The week included Sun Day, May 3, which was proclaimed by President Carter for the nation and by Governor Ray for the State of Washington.



Special activities, attracting more than 2,000 people, were sponsored by the Hanford Science Center, Pacific Northwest Laboratory, and Olympic Engineering Corporation.

The week was kicked off by Congressman Mike McCormack as he dedicated Project Sunburst, a facility built by Olympic Engineering to demonstrate the feasibility of solar heating and cooling. The facility was built on a cost sharing basis with DOE under the Commercial Solar Heating, Cooling and Hot Water Heating Demonstration Act. That same day, the Hanford Science Center reopened following several weeks during which the facility was closed for the installation of new exhibits.

Visitors to the Science Center saw exhibits and demonstrations on a variety of solar applications--wind and ocean, as well as direct solar applications. Visitors at the Pacific Northwest Laboratory observed both active and passive solar systems, including a biomass exhibit. At Olympic Engineering, emphasis was on the solar system installed in the facility.

CHARLES RIPLEY, Olympic Engineering, and Congressman Mike McCormack view Project Sunburst's solar driven absorbtion chiller. Water is chilled and then used to cool air in the building. Circulation pumps and piping are shown in the background.

## Tri-City Herald

### SUNDAY, OCTOBER 1, 1978

SECOND PAGE ONE

## Sunburst records energy savings

#### By TODD CROWELL Herald Staff Writer

Project Sunburst, the \$700,000 solar demonstration project in Richland, saved about \$500 worth of energy during its first summer of operation, officials estimate.

Project manager Charles Ripley of Olympic Engineering, which is running the experiment for the Department of Energy, said even though it would take about 700 years to amortize No the solar equipment at that rate of savings, he is undaunted.

"With a tweaking of controls, more insulation, and other improvements, we expect to save much more," Ripley said.

He said since startup last Pebruary, the solar building has used about 46,000 fewer kilowatt hours of electricity than the conventional companion building, for a saving of \$500.

Project Sunburst is an experiment using two identical commercial buildings. one heated and cooled by solar energy, the other by conventional electric powered heat pumps.

The Olympic project is one of about 75 solar denionstration projects funded by the Department of Energy around the country, but, according to Ripley, it

is the only one that is paired with a conventional "control" building to make direct cost comparisons.

The solar collectors were in place and ready to go atthe end of last year, but it wasn't until late February that there was enough sunlight to run the system.

Since then, it has been operating almost continuously except for a threeweek shutdown in mid-summer to allow installation of a data acquisition system, Ripley said.

The system monitors temperatures in the solar heating system and relays the information to a central computer in Huntsville.

Ripley said this summer demonstrated the reliability of the solar-powered "aborption chiller," which functions as the building's air-conditioner.

"It was adequate for cooling the building even during the hettest days," he said.

The system actually collected more heat than it could use during the hot months, and much of it had to be dumped into cooling ponds that surround the building.

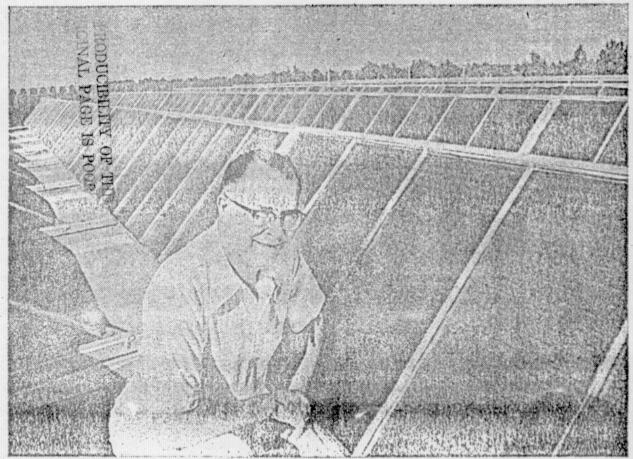
Next year Ripley hopes to install a device that will use some of this wasted heat to preheat city water before the water enters the solar heater.

Ripley said it is too early to make any conclusions about solar energy. The

program calls for collecting information over the next five years.

. Meanwhile, the unique so-

lar building continues to be a popular tourist attraction with about three tours a week. Anyone wanting to see the building at close hand can do so by calling Olympic Engineering at 375-3069.



Charles Ripley examined the solar collectors that helped save \$500 in energy costs during

the past six months of "Operation Sunburst,"

Individual Copy Price 11450

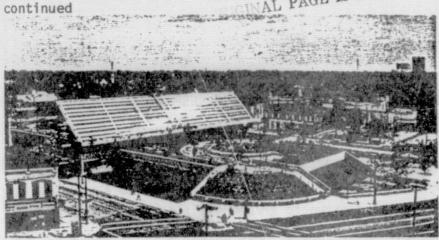
# SO arr engineering magazine

The Official Publication of the Solar Energy Industries Associations 2015 197

Special issue: solar cooling.

Projects and prototypes

Components and systems



The air conditioning system at the U.S. Federal Office Building in Saginaw, Mich., gets about a 50% portion of its energy via these Owens-Illinois Sunpak® evacuated tube collectors.

(continued from page 25)

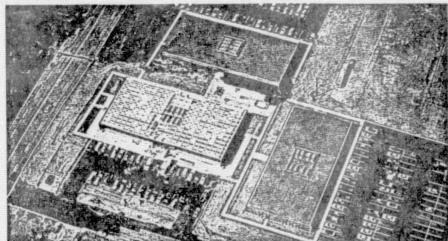
According to the report: "The solar energy available to the energy collection and storage system was 482 million Btus. The reported values of collected solar energy are biased due to the location of a temperature probe next to a hot water pipe. This influences the collector array efficiency resulting in a lower than expected value. Storage efficiency for the month was 0.396. This number reflects the unintentional 24 hour-per-day operation of the collector loop pump for the first 12 days of the month and the biased temperature probe data.'

The report concluded: "Shenandoah has no major solar energy system or data system problems." The down-time of the system due to the later freeze problems in the plumbing caused the unavailability of further data, Moore noted.

He said that the low 15% of the total supply for hot water was due to the unique requirements of a Zamboni machine which uses up to 1,600 gallons of hot water a day on the ice rink to smooth the skating surface. "The ice in the hockey-sized ice rink, of course, is manufactured by an ordinary compressor which is powered by electricity, and does not interface with the solar." Moore added.

The building cost \$2.4 million, with the solar portion of \$726,904 supplied by an ERDA (now DOE) grant. There was an estimated \$77,000 yearly savings on fuel projected for the center at current fuel prices. The Shenandoah Development Corp. funded the non-solar portion.

System recap. Building area: 59,000 square feet, new Collectors 63, 8 × 21 flat plate, Revere Solar and Architectural Products, Inc., Rome, N.Y. Storage: 15,000 hot water; two 30,000 cold water underground tanks. Absorption chiller: 200-ton Trane. Architect: Taylor and Collum, Atlanta, Ga. Solar design: Georgia Institute of Technology, Atlanta, Ga. Engineers: Richard Wright and Associates and Newcomb and Boyd, Atlanta, Ga. General Contractor: Baston-Cook Co., Atlanta, Ga. Operating date: April, 1977. Monitoring: Georgia Tech for DOE. Financing: \$2.7 million total; solar, \$726,904, ERDA



Project Sunburst, the DOE demonstration in Richland, Wash. involves two identical buildings. The Olympic Engineering Corp. building, foreground, has the solar system, while the control building at the left has the same design except without the solar system.

Page 26 solar engineering May 1978

#### Corporation building in North Richland, Wash. since Feb. 10, is expected to supply 97% air conditioning, 71% heating and 90%

Olympic Engineering Corp. The solar system operating at the

new Olympic Engineering

domestic hot water.

The single-story brick structure has 14,400 square feet and houses 100 employees of the Olympic R&D Department and the Washington Public Power Supply System. It is one of two identical buildings in "Project Sunburst," part of the DOE solar demonstration program. The building next door has the same floor plan, site orientation and energy saving devices, but does not have a solar system. The control building is occupied by Battelle Northwest Laboratories and is heated and cooled by conventiona! electric heat pumps.

There are 252 (6,000 square feet) General Electric flat plate aluminum collectors, double glazed with LEXAN®. Pumps are by Bell & Gossett and controls by GE. Storage is in two insulated steel underground tanks, a 9,000 gallon tank for hot water, by T.E.S., and a 2,000 gallon cold water tank by Welk

Brothers.

The solar ties into a 25-ton lithium bromide absorption chiller by Arkla. The backup system is eight Carrier heat pumps, each five tons. Each passage through the solar collector array heats the 33% glycol/water mixture 16°F. The heated liquid goes to an exchanger in the basement, where heat is transferred to city water in the 9,000 gallon

While air conditioning, hot water is pumped from the tank to the chiller, which cools water from 55° to 45° at a rate of 4,000 gallons an hour to charge the 2,000 gallon tank. That chilled water is pumped to coils in the building's distribution system.

Total system cost was \$845,726, of which the solar portion was \$747,226. A cost sharing project, the solar was funded by \$710,000 from DOE and over \$37,000 from Olympic. The program is 95% public financed under the Commercial Solar Heating and Cooling Demonstration Act.

stem recap. Building area: 14,400 square feet, ne Collectors: 252 flat plate aluminum, 6,000 square feet, General Electric, Philadelphia, Pa. Absorption chiller: 25-ton Arkla, Evanston, Ind. Backup: 85-ton heat pumps, Carrier Corp., Syracuse, N.Y. Operating date: February 1978. Performance: 97% air conditioning, 71% heating, 90% hot water. Financing: DOE solar heating and cooling daments of the property of the pr ing demonstration cost sharing project, \$747,226 DOE grant, \$37,000 Olympic Engineering. Architects: Tracey-Brunstrom-Morgan, Seattle, Wash. Engineers: Olympic Engineering Corp., Richland, Wash.

#### PUBLIC SPEECHES AND TOURS AND PUBLIC RESPONSE

A list of public speeches on Project Sunburst is included herein. In addition to the 55 formal speeches, the list includes references to about one-third of the one hundred or so tour-talks given to groups visiting the project.

For many of these speeches press notices were obtained, a sampling of which is also included.

The response to Olympic's efforts to foster public awareness of Project Sunburst is manifest in two forms; response in the form of letters and response to the invitations to visit the facility. The wide range of groups demonstrating an interest in Project Sunburst is suggested by the letters and tour documentation shown herein, and also the entries in the speech log.

A guest register has been made available for visitors to sign. Typically, only a few persons from each group sign this register, but the number of group entries exceeds 100, which would represent the number of tour-talk presentations given, and the number of actual visitors would exceed 2,000.

A display of the fluid temperatures and a diagram of the system operation are provided for visitors, along with a hand-out (sample shown) and copies of several newspaper reprints and other items made available for visitors.

Dago

Included in this section are:

Partial List of Speeches Publicity for Speeches	rage
Publicity for Speeches	D-29-31
	D-32
Sample of Visitor Hand-Out	D- 33
Samples of Public Responses	D-34-40
Sample Tour Itineraries	D-41-46

### PARTIAL LIST OF SPEAKING ENGAGEMENTS AND TOUR-TALKS

### DELIVERED BY

### CHARLES C. RIPLEY, P.E.

### ON PROJECT SUNBURST

1976		ON PRODUCT SUNDORS!
May		Tri-Cities Chamber of Commerce Talk to Alex Fremling, D.O.E. Manager and his staff
Jun	10	Richland Business and Professional Women's Club and Richland Chamber of Commerce Joint Meeting
Jun Jun Jun	24	Kennewick Rotary Club Richland Cable TV (40-Minute) presentation of June 10 Talk Pasco-Kennewick Rotary CLub
Jul	16	Tri-Cities Visitor and Convention Bureau
Aug	24	Richland Rotary Club
Oct Oct		Real Estate Appraiser's Association Kiwanis Club of Kennewick
1977	•	
Jan Jan Jan	25	Tri-City Chapter Non-Destructive Testing Society Boise Cascade Management Association (Wallula, Wa.) Richland Altrusa
Feb Feb Feb Feb	15 17 18	Pasco Kiwanis Club American Institute of Electrical Engineers ERDA, Presentation to Staff and Site Major Contractors Eastern Washington State College Facilities Director and Staff (Cheney, Wa.) Democratic Saturday Club
Mar Mar Mar	17	ERDA Contractors Energy Coordinators (Tour-Talk) Dimension '77 Architects and Engineers Seminar sponsored by the Electric League of the Pacific Northwest, and Northwest Electric Light and Power Association with 800 attendees (Seattle) Solar and Energy Orientation Meeting, all personnel Olympic
Mar	23	ERDA sponsored Solar Orientation Seminar for Local Builders
May May		Washington State Association of Chambers of Commerce Annual Meeting Australian TV Network with Congressman Mike McCormack (Filming)
Jun Jun Jun	15	Refrigeration Engineers and Technicians Association (Tour-Talk) Student Competition of Relevant Engineering (SCORE) (Talks and Tour-Talk American Institute of Architects Southeastern Washington Chapter (Tour-Talk)
Jul Jul		Hanford Science Center Staff (Tour-Talk) Northwest Solar '77 Seminar ERDA sponsored (Portland, OR)
Aug	20	State of Washington Assembly Legislators of Senate and House Energy Committees (Tour-Talk)

#### 1977 Cont'd Northwest Regional Convention American Society for Quality Sep 15 Control (Seattle) Sep 20 Tri-City Chapter, American Society for Metals Oct 05 Annual Meeting, Northwest Public Power Association (Springfield, OR) Oct 08 9th Annual Convention (Joint), Washington Movers Conference, and Washington State Warehousemans Assoc. (Talk and Tour-Talk) Oct 21 Solar Energy Seminar, Sponsored by Columbia Basin Chapter, American Institute of Plant Engineers (Portland, OR) Oct 29 Formation Meeting Inland Empire Chapter (American Section) International Solar Energy Society Nov 03 Mid-Columbia Chapter of American Institute of Plant Engineers Nov 10 Presentation to Idaho Falls Chamber of Commerce Nov 17 Annual meetings and Joint Banquet & Washington State Reclamation Association, and Nov 18 Washington Association of Irrigation Districts Dec 04-Paper presented, D.O.E. Solar Workshop (New Orleans, LA) Dec 07 1978 Feb 01 KIONA-Benton H.S. Science Students (Tour-Talk) Feb 15 American Institute of Industrial Engineers Feb 16 Boy Scouts of America (Tour-Talk) Feb 21 Juvenile School (Tour-Talk) Feb 22 Washington State Life Insurance Underwriters (Tour-Talk) Mar 11 American Society of Certified Engineering Technicians Convention (Tour-Talk) Mar 14 Society of Women Engineers Mar 22 Klickitat County P.U.D. Public Meeting (Goldendale) Mar 23 Prosser Rotary Club (Prosser) Apr 18 J.M. Perry Institute (Yakima) Apr 21 NASA Project Managers (Tour-Talk) Apr 25 Lawrence Livermore Lab Engineers (Tour-Talk) Apr 26 Govenor D.L. Ray (Tour-Talk) May 01 Kamakian H.S. Science Class (Tour-Talk) May 03 Joint Center for Graduate Study (Tour-Talk) May 04 Sacajawea School Children (Tour-Talk) May 05 Garfield School Science Students (Tour-Talk) May 05 Mortgage Bankers Association (Tour-Talk) May 06 Seattle Science Center Solar Fair May 07 Seattle Science Center Solar Fair May 16 Junior H.S. Science Class (Tour-Talk) May 17 Eastern Washington University Conservation Students (Tour-Talk) May 19 Washington Society of Professional Engineers Seminar (Olympia) May 20 Urban Solar Seminar (The Dalles)

### Page Three

1978 Cont'd	REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR
May 24	Hanford Science Center (Tour-Talk) J.A. Jones Engineering Staff (Tour-Talk) Spokane Chamber of Commerce (Tour-Talk)
Jun 06	Boy Scouts of America (Tour-Talk)
	Energy Forum Northwest Univ. of Washington (Seattle) School (Tour-Talk) Goldendale Citizens (Tour-Talk) Tri-City Herald (Tour-Talk)
	Washington Society of Professional Engineers (Spokane) Association of Industrial Arts Instructors (Walla Walla) Portland U.S. Naval Reserve (Tour-Talk)
Nov 08 Nov 09 Nov 09 Nov 10	Rosalia Chamber of Commerce (Tour-Talk) Royal High School Science Students (Tour-Talk) Prosser High School Science Students (Tour-Talk) Big Bend College (Tour-Talk)
1979	
Jan 27	Annual Meeting Refrigeration Society
Feb 17	ASME Meeting Washington State University Physics and Astronomy High School Physics
	Nuclear Energy (Women) High School Tour
Apr 27	Sunburst Tour Home Economics Convention Energy Conservation Talk Convention Home Economics AUW Conference (5 tours)
	American Association Industrial Arts Annual Convention
	Washington Society of Professional Engineers Solar seminar and annual meeting (Renton)

### TRI-CITY HERALD JUNE 7, 19 76

### Solar energy to be topic

"Solar Energy in Richland"
will be discussed at noon
Thursday at a Richland
Chamber of Commerce luncheon in the Rivershore Motor
Inn.

research and development for Olympic Engineering Corp The north Richland firm

Speaker will be Charles C.

Ripley, manager of energy

The north Richland firm recently received a \$500,000 grant from the Energy Research and Development Auministration to conduct a controlled scientific experiment using solar power to heat and cool a commercial building.

Groundbreaking took place Friday.

JUNE 14, 1976

### Solar energy talks on tv

Charles Ripley, Olympic Engineering, will speak on solar energy on Richland Channel 13 at 5 p.m. Tuesday and 6:30 p.m. June 24.

The station will rebroadcast the talk Ripley gave Thursday to a joint meeting of the Richland Chamber of Commerce and Richland Business and Professional Women.

Ripley, manager of energy research and development, also will speak at noon Wednesday at the Red Lion in Pasco to the Pasco-Kennewick Rotary Club. DEC. 12,1977

### Women Engineers

"Energy Conservation," perservation", personal and sonal and world-wide, will be discussed when the Eastern Washington Section of the Society of Women Engineers meet at 7:30 p.m. Tuesday in the Hanford Science Center.

Lyle Wilhelmi of the Hanford Science Center and Charles Ripley of Olympic Engineering will speak. The public is welcome. MAY 1751978

### Ripley to address solar meet

Charles Ripley, senior energy consultant for Olympic Engineering Corp., will speak at 4 p.m. Friday to the Washington Society of Professional Engineers Solar Energy Seminar in Olympia.

Ripley's topic will be "Project Sunburst and Solar Energy in the Built Environment."

The seminar is to provide engineers with an understanding of the use of solar energy for heating and cooling in the Northwest

System design, cost effectiveness, available equipment, energy storage, tax incentives and climate factors will be covered in the seminar.

Ripley is chairman of the Tri-City Nuclear Industrial Council's Residential Energy Savings Committee

MAY 4, 1978

### Tri-Citian to address solar fair

Charles C. Ripley of Richland will address the Solar Fair at the Pacific Science Center in Seattle Saturday and Sunday, a center spokesman said. Susan Stocker, with the center, said Ripley will discuss "Project Sunburst and Solar Energy in the Built Environment."

Ripley is senior energy

consultant for Olympic Engineering Corp, of Richland and is chairman of Tri-City Nuclear Industrial Council's Residential Energy Savings Committee. PROJECT INFORMATION - ERDA COMMERCIAL SOLAR DEMONSTRATION

Solar System Owner/ Manager: Olympic Engineering Corporation Architect-Engineer: The Tracey-Brunstrom-Morgan Partnership

Builder: Development Dynamics Company of Richland Location: Richland, Washington, Latitude 46° 20' N

Building Type: Single Story, Brick Office

Climatic Data: Degree Days Heating 5267; Cooling 800 Average Temperature: Winter 29; Summer 77

Peak Daily Insolation: December 336 Btu/sq ft July 2432 Btu/sq ft

BUILDING DESCRIPTION

The project involves two identical buildings at the same site with identical orientation. Building one, a control; is heated and cooled by heat pumps. Building two, the demonstration, is provided with solar space heating/cooling and solar water heating by flat-plate collectors mounted on the flat roof with heat pump backup. Each building has 14,400 square feet of floor area. Energy conservation measures include insulation, double glazing, selective absorptive/reflective slat drapes and reflective ponds. Energy use will be compared between buildings.

SOLAR ENERGY SYSTEM

Solar Application: 71% Heating, 97% Cooling and most of the

Collector: 6000 ft<sup>2</sup> flat-plate aluminum with two layers of LEXAN<sup>R</sup> Manufactured by General Electric.

STORAGE:

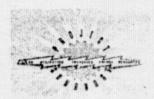
Insulated 2000 gallon chilled water storage and 9000 gallon hot water storage tanks located underground. Ethylene glycol/water transfers solar heat through exchange to secondary hot water storage loop.

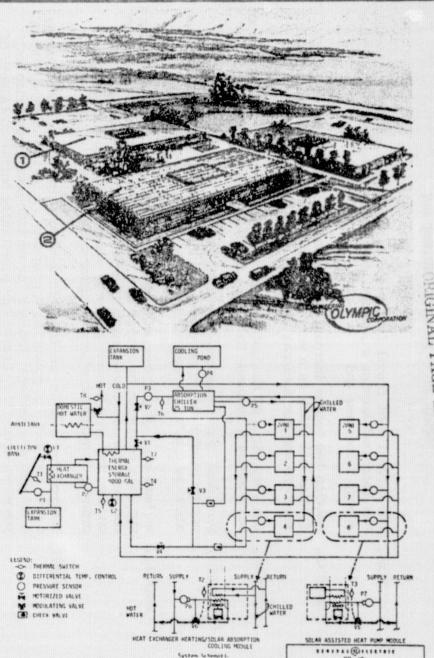
DISTRIBUTION:

Forced Air: The building incorporates solar assisted heat pump heating and conventional heat pump cooling by utilizing direct heat exchanger heating and solar driven absorption cooling systems.

DOMESTIC HOT WATER SYSTEM:
Water is heated by a solar thermal energy exchanger which also recuperates heat dumped by the chiller during the cooling season.

PROJECT SUNBURST Olympic Engineering Corporation 3070 George Washington Way Richland, WA Phone (509) 946-4161





### PROCLAMATION

#### APRIL 29 -- PROJECT SUNBURST DAY

- WHEREAS, the depletion of fossil fuel resources and their rapidly rising costs has increased America's interest in the development of alternative energy resources; and
- WHEREAS, America has become increasingly dependent on the importation of foreign oil which is a very real threat to our continued economic strength and our national security; and
- WHEREAS, the very birth of Hanford and the Tri-Cities area was the result of our country's response to a very critical national need; and
- WHEREAS, President Carter has proclaimed the national effort to solve our energy needs must be seen by our public officials and our citizens alike as the "moral equivalent of War"; and
- WHEREAS, we have sent Congressman Mike McCormack to the National Legislature who is a scientist himself and has become the leading voice in the Congress for the development of an energy policy which will lead our country on a course of energy independence and the rapid and orderly development of energy alternatives; and
- WHEREAS, Project Sunburst is one tangible demonstration of our solar energy capability and its potential application right here in the City of Richland, the National Capital for nuclear power production and research, shows the diverse and potentially unlimited talents of the people of the Tri-Cities and especially Richland in their overall leadership in the solar energy field as well;

NOW, THEREFORE, I, Thomas M. Logston, by virtue of the authority vested in me as the Mayor of the City of Richland, hereby proclaim April 29, 1978, as

#### PROJECT SUNBURST DAY

in the City of Richland and urge all our citizens to take part in the Sumburst events and dedication ceremonies planned by the Olympic Engineering Corporation to promote public awareness of solar energy.

IN WITNESS WHEREOF, I have hereunto set my hand and caused to be affixed the seal of the City of Richland this 24th day of April, 1978.

Mayor, City of Richland

MIKE McCORMACK

4TH DISTRICT, WASHINGTON

COMMITTEES

PUBLIC WORKS AND TRANSPORTATION

SCIENCE AND TECHNOLOGY

CHAIRMAN

SUBCOMMITTEE ON ADVANCED ENERGY TECHNOLOGIES AND CONSERVATION

AD HOC COMMITTEE ON ENERGY

Congress of the United States House of Representatives

Washington, D.C. 20515

May 8, 1978

WASHINGTON OFFICE: 1202 LONGWORTH HOUSE OFFICE BUILDING (202) 223-5816

FEDERAL BUILDING
RICHLAND, WASHINGTON 99332
(509) 942-7273

305 NORTH 3RD STREET, SUITE & YAXIMA, WASHINGTON 98901 (509) 248-0103

FEDERAL BUILDING, 500 12TH VANCOUVER, WASHINGTON 98660 (206) 696-4041, Ext. 256-7

WENATCHEE, WASHINGTON 98801

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Ms. Barbara Anthony Olympic Engineering Corporation 3070 George Washington Way Richland, Washington 99352

Dear Barbara:

I want to express my thanks to you and all of the others at Olympic Engineering for making the "Project Sunburst" dedication ceremonies such a memorable occasion.

I understand that it was primarily through your efforts that the afternoon's festivities went so smoothly. I want you to know that I thoroughly enjoyed both the dedication and the reception that followed.

Congratulations on a job well done!

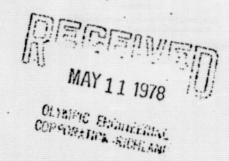
Sincerely

Mike McCormack Member of Congress

MMc:mr



Department of Energy Richland Operations Office P.O. Box 550 Richland, Washington 99352



May 10, 1978

Dr. Enmett B. Moore, Jr.
General Manager - Richland Division
Olympic Engineering Corporation
2592 George Washington Way
Richland, Washington 99352

Dear Dr. Moore:

I wish to thank you on behalf of the Department of Energy, and myself, for your participation in the SUN DAY activities on May 3. You have always been most helpful and cooperative in opening up your facilities for public viewing, and providing excellent tours and comments on your solar demonstration project.

Please express my appreciation to other members of your staff who participated in making SUN DAY an interesting and informative time for residents of this area.

Sincerely,

Robert H. Lindsey Assistant Manager for Regional Activities

Copies to: Charles Ripley

Bob Poplin

Vince FitzPatrick

Peter Jobs Bob Irwin



Kenneth E. Johnson Environmental and Energy Center

October 5, 1978

P. O. Box 1247 Huntsville, Alabama 35807

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Charles C. Ripley Olympic Engineering Corp. 3070 George Washington Way Richland, Washington 99352

Dear Sir:

Reference your letter of March 2, 1978. Please forward a set of your slides that was used in your New Orleans presentation, along with a short description of each visual.

An extensive library is being developed for the Department of Energy, also these materials are needed for possible use at the Solar Heating and Cooling Contractor's Review to be held in San Diego during December of this year.

Thank you for your cooperation in previous efforts to document the progress of our national solar energy program.

Sincerely,

David L. Christensen

Senior Research Associate

# Opinion Page

## Rotarians see results of solar heating, cooling

Olympic Engineering Corporation of Richland has "switched on the sun" to heat and cool its building in Hanford Square in North Richland.

The demonstration is financed by a \$710,000 grant from the Department of Energy under the Commercial Solar Energy Heating, Cooling and Water Heating Demonstration Act. It is a cost sharing project and Olympic has contributed nearly \$37,000 under the contract.

nearly \$37,000 under the contract.

Charles C. Ripley, senior energy consultant for Olympic, was in Prosser March 23 to tell Prosser Rotarians about it. The solar system is operating and the Project Sunburst building was first heated by stored solar energy Feb. 10, 1978.

The 14,400 square foot solar building at 3070 George Washington Way is occupied by Olympic's Research and Development Department and the Washington Public Power Supply System. It will receive 97% of its air conditioning and 71% of its heating from the sun. Ninety percent of its hot water also will be solar-heated.

The solar building occupied early in 1977 has been operating on its back-up heating and cooling system consisting of electrically driven heat pumps while final instrumentation wiring is being completed prior to testing.

An identical 14,400 square foot control building next door, occupied by Battelle Northwest Laboratories, is heated and cooled by conventional electric heat

When electrical costs are compared between the demonstration and control buildings over a five-year test period this practical example of the classic scientific controlled experiment will show actual savings that can be made using solar energy.

Heat from the sun is collected by flat plate collectors and delivered to a tank of 33% ethylene glycol/water mixture, passing through at a rate of 126 gallons per minute.

Each passage through the solar collector array heats the fluid 16 degrees F. The heated liquid then goes to a heat exchanger in the solar basement, and is transferred to city water in a 9,000 gallon insulated thermal energy storage tank buried under the sidewalk outside the basement.

Upon call by thermostats in the building, water at 120° to 160° Fahrenheit is pumped to heating coils in the building's room air distribution system.

During the summer, when the thermostats call for air conditioning, hot water is pumped from the thermal energy storage tank to a 25 ton absorption chiller, which cools water from 55 to 45 degrees at a rate of 4,000 gallons an hour to charge a 2,000 gallon cold water storage tank. That chilled water is pumped to the same coils, which cool the air in the building's distribution system.

After initial acceptance testing is completed this spring the solar building will be open to the public for scheduled tours, to include an exhibition hall and inspection of the entire solar system with real-time instrumentation.

Tourists will be able to climb to the roof to see and feel the 6,000 square foot array of 252 solar collectors and to the basement to observe the solar heat transfer and control system.

Rotarians were shown a slide presentation covering Project Sunburst and other solar projects in this area.

ORIGINAL PAGE IS POOR

REPRODUCIBILITY OF THE Debruary 9, 1977 Dear Mr. Ripley, I wish to thank you again for the interesting and informative talk on solar energy you gave to the (Altrusa) Olub recently. It certainly spened our eyes to the possibilities of a new source of energy. By recent news articles about water shortages in our area, we may need new types of energy source & sooner than we think! I wish you all good fortune and success in your ventures in the future and hope we have the opportunity to hear from you again. Let's hope the sun shines through the clouds more in the near future than in the recent part!

Sincerely, Altrusa Club Members

#### CHRIST THE KING SCHOOL

1122 LONG AVENUE . .

RICHLAND, WASHINGTON 99352

Mr. Charles Repley 1947 201013 Olympic Engineering

Dear sir:

Thank you for taking the time and interest to show Project sumburst to the eight grade of christ the King school.

and gave us a better understanding of the solar Energy Program.

> Sincerely, Eight Wraders Onriet the King School

#### EPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

#### HANFORD TOUR ITINERARY

\*S.C.O.R.E., GROUP 1 & 2 Wednesday, June 15, 1977 REGENVED JUN 7 1977

Escorts: AM--Jim Kelly, PM--Jack Miller Approximately 25-40 Students per tour

Transportation: ERDA Bus

Contact: Bill Cawley, Chris Corbett

OLYMPIC ENGINEERING CORPORATION - RICHLAND

Group	#1	-	MA	Tour

	8:30 AM	Begin tour at Joint Center for Graduate Stud
	8:30 - 8:45	Travel to FFTF Site
	8:45 - 9:30	Tour FFTF Site, Visitor's Center
	9:30 - 9:40	Travel to WPPSS Hanford No. 2 Power Plant
	9:40 - 10:00	Tour WPPSS Hanford No. 2, Viewing Stand
	10:00 - 10:15	Travel to Olympic Engineering
<	10:15 - 11:15	NTour Olympic's "Project Sunburst"
	11:15 - 11:30	Return to Joint Center/Grad. Study

#### Group #2 - PM Tour

12:30 PM	Begin tour at Joint Center for Graduate Study
12:30 - 12:45	Travel to FFTF Site
12:45 - 1:30	Tour FFTF Site, Visitor's Center
1:30 - 1:40	Travel to WPPSS Hanford No. 2 Power Plant
1:40 - 2:00	Tour WPPSS Hanford No. 2, Viewing Stand
2:00 - 2:15	Travel to Olympic Engineering
2:15 - 3:15	Tour Olympic's "Project Sunburst"
3:15 - 3:30	Return to Joint Center/Grad Study

#### DISTRIBUTION

ERDA Security	G.	D.	Carpenter, HEDL
T. A. Bauman, ERDA	*P.	G.	Rhoades, ERDA
T. L. Best, ARHCO	D.	W.	Mazur, ERDA
K. Bazemore, ARHCO	F.	К.	Purcell, ARHCO
R. L. Elmgren, WPPS	S W.	C.	Bowen, ARHCO
F. C. Zerza, HEDL	К.	R.	Heid, BNW
H. E. Hylbak, HEDL	F.	Ε.	Williamson, HEDL
W. E. Cawley, ERDA	C.	Ri	pley, Olympic
n. L. Cantey, Liter	•		picy, orympic

ATLANTIC RICHFIELD HANFORD COMPANY Communications & Public Affairs Hanford Science Center (509) 942-6602

\* STUDENT COMPETITION ON RELEVANT ENGINEERING FINALISTS IN NATIONAL ALTERNATE ENERGY CONTEST D-41

#### DETAILED AGENDA

#### Visit to Hanford

by

Washington State Committees on Energy and Utilities, Agriculture, and Ecology

August 20, 1977

#### Saturday, August 20, 1977

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est entrance of Federal
tel
by Fremling
le, State Department, , regarding Hazardous nford
bus will travel to its will be placed on board
o-host lunch
: Lindsey
de: Dunn
Plant (thru side gate)
ess
nts
ant No. 2 by Phil Otness
g Facility

Tour Complete

Coordinated by: J. L. Tokarz 942-6288

8/15/77

#### Membership Listing for the State of Washington House and Senate Committees on Energy and Utilities, Ecology, and Agriculture

REPRODUCIBILITY OF THE

#### Senate Energy & Utilities Committee

R. Ted Bottiger, Chairman
Del Bausch, Vice-Chairman
Max E. Benitz
Marcus S. Gaspard\*
Jeannette Hayner
Al Henry
James E. Keefe
R. H. Lewis
Bruce A. Wilson\*

#### Senate Ecology Committee

Nat W. Washington, Chairman Hubert F. Donohue H. A. "Barney" Goltz Sam C. Guess John S. Murray Lois North Ruthe Ridder

#### Senate Agriculture Committee

Marcus S. Gaspard, Chairman\* William S. Day F. "Pat" Wanamaker Bruce A. Wilson\*

#### Senate Staff Members

Ken Madsen, Staff Director John Woodring Bob Lee Bob Walton Curt Eschels Terese Mulgrew Park Cann

#### House Energy & Utilities Committee

King Lysen, Chairman Marion Kyle Sherman, Vice-Chairwoman Ron Dunlap, Ranking Minority Member Duane Berentson R. M. "Dick" Bond Donn Charnley Paul H. Conner Dan Grimm Simeon R. "Sim" Wilson Charles D. Kilbury\* William Leckenby\* John Martinis Geraldine McCormick John S. McKibbin Cathy Pearsall Al Williams

#### House Ecology Committee

Georgette Valle, Chairwoman
Paul Pruitt, Vice-Chairman
Scott Barr, Ranking Minority Member
Red Chandler
Jeff Douthwaite
Jack W. Grier
Audrey Gruger
Jerry M. Hughes
George S. Hurley
Mike Kreidler
William Leckenby\*
Claude L. Oliver
Earl F. Tilly

<sup>\*</sup>Serves in dual capacity

#### House Agriculture Committee

Charles D. Kilbury, Chairman\*
Otto Amen, Ranking Minority Member
Mary Kay Becker
Jim Boldt
Harold Clayton
Helen Fancher
S. E. "Sid" Flanagan
Frank "Tub" Hansen

#### House Staff Members

Tom Casey Ken Hirst Henry Romer Ron Quist

\*Serves in dual capacity

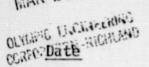
JLT:10m - 3/17/77

#### GRADUATE STUDENTS

#### NUCLEAR, CHEMICAL AND MECHANICAL ENGINEERING SEMINAR

Joint Center for Graduate Study, Spring 1978

Wednesday, 8 p.m., Room 117



Are. Date	Speaker	Topic
March 29	Mr. Jess Greenborg Battelle-Northwest	Class perspectives and "Energy Update"
April 5	Tentative: Dr. Harold Forsen Exxon Nuclear Corp.	Laser Enrichment of Uranium Isotopes
April 12	Mr. David Amerine Westinghouse Hanford Co.	Tour of FFTF Facility (FFTF Site at 7:30 p.m.)
April 26	Dr. Charles Rohrmann Battelle-Northwest	Biomass Conversion
May 3	Mr. Charles C. Ripley Olympic Engineering	Tour of the Solar Energy Building (Olympic Engineering 7:30 p.m.)
May 10	Mr. Marvin Zimmerman Battelle-Northwest	The Effect of the Anisotropy Model on Transport Calculations
May 17	Dr. Bob Masterson Battelle-Northwest	Numerical Methods for Reactor Thermal Hydraulics
May 24	Mr. Joseph Lucas Washington Public Power Supply System	Tour of WNP2 (WNP2 Site at 7:30 p.m.)
May 31	Dr. Bert Scheffler, JCGS Mr. Jess Greenborg Battelle-Northwest	Seminar Review (Time and place to be announced)

#### HANFORD ITINERARY TOUR

#### Hillyard Center

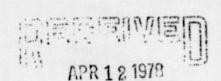
#### Monday April 17, 1978

Tour Director: Jack Miller

Approximately: 34 Senior Citizens
Transportation: 1 Mini Bus

Contact Elnor Nuxoll

H. A. Haines, Rockwell



OLYMPIC EIGHEERING COSPORATION - RICHLAND

	10:30	Arrive at Hanford Science Center
	10:30 - 11:00	Rest Break
	11:00 - 12:15	Tour Hanford Science Center
	12:15 - 1:00	Lunch Break
	1:00 - 1:15	Travel to Olympic Engineering Corporation
<	1:15 - 1:50	Tour Project Sunburst, Speaker Charles Ripley
	1:50 - 2:05	Travel to Fast Flux Test Facility & Visitor Center
	2:05 - 2:45	Tour FFTF & Visitor Center
	2:45 - 3:00	Rest Break
	3:00 - 3:10	Travel to Washington Public Power Supply System Nuclear Plant #2
	3:10 - 3:30	Tour WPPSS Nuclear Plant #2
	3:30	Return to Richland

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C. S. Carlisle, DOE	F. C. Zerza, HEDL	L. Wilhelmi, Rockwell
O. L. Olson, DOE	J. Menard, HEDL	

No Radiation Dosimeter will be issued since this tour is all Public Access. The Tour Director will be security badged.

F. E. Williamson, HEDL

#### PUBLISHED PAPERS

Papers have been published on Project Sunburst in conjuction with three conferences: The Architects and Engineers Seminar in Seattle, March 17-18, 1977; the D.O.E. Solar Workshop in New Orleans, December 4-7, 1977, and the D.O.E. second Solar Heating and Cooling Demonstration Contractor's Review in San Diego, December 13-15, 1978. Only the third paper is included herein, since the other two are earlier versions and therefore less relevant (the first of the three was prepared by the sponsor directly from the oral presentation).

Sample pages from the first two have been included.

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New Orleans Conference	D-50
San Diego Conference	D-51-61



ARCHITECTURE/ENGINEERING/ENERGY MANAGEMENT IN THE BUILT ENVIRONMENT

#### **ARCHITECTS & ENGINEERS SEMINAR**

SEATTLE CENTER MARCH 17-18 1977

#### **SPONSORS**

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#### **PROCEEDINGS**

Summary notes of the seminar presentations will be mailed to all requesting participants at the conclusion of the seminar. Please complete the mailing label included in your registration packet and return it to the registration desk.

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PROCEEDINGS

NINGITATION



ARCHITECTURE/ENGINEERING/ENERGY MANAGEMENT IN THE BUILT ENVIRONMENT

**ARCHITECTS & ENGINEERS SEMINAR** 

#### REGISTRATION

10:00 a.m. to 4:00 p.m. Thursday, March 17 Rainier Room 7:30 a.m. to 1:00 p.m. Friday, March 18 Rainier Room REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Conducted by Northwest Electric Light & Power Association and the Electric League of the Pacific Northwest.

D-48

#### PROGRAM/SPEAKERS

THURSDAY AFTERNOON/March 17/Seattle Center Playhouse

10:00 a.m. to Noon

**国现代的任务的证明** Registration at Playhouse.

Noon to 1:00 p.m.

Luncheon in San Juan Room. Master of Ceremonies will be Gordon Vickery, Superintendent of Seattle City Light.



1:00 p.m.

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2:40 p.m.

3:40 p.m.

10:45 a.m.

"Welcome and Challenges." John W. Ellis, President of Puget Sound Power & Light Company, Bellevue, Washington, welcomes participants, explains the challenges in designing, building and providing power to operate the built **计。指数性验** 



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"Energy Conservation as a Resource." The Administrator of the Bonneville 2:00 p.m. Power Administration, Don Hodel, presents an insider's view of load forecasting, the interrelationship of energy sources, and a look at proposed conservation methods.

> "Energy Management and Utilization Technology Development at Electric Power Research Institute." Dr. Fritz R. Kalhammer of Palo Alto's well-known research firm, EPRI, explains fuel cell and chemical energy technology; energy storage; and the structure of Electric Power Research Institute.

COFFEE and SOFT DRINKS 3:20 p.m.

> "Project Sunburst." The Manager of Energy Research and Development of Olympic Engineering Corporation, Richland, Washington, Charles C. Ripley, P.E., describes how two identical, adjacent buildings in Richland were built for the purpose of comparing conventional electrical energy use with complementary solar space heating/cooling and solar water heating.

> > (Continued on next page)

"Energy Management Case Studies." Charles Robart, the speaker, represents 2:00 p.m. the Edison Electric Institute in New York City.

"United States Energy Policies and Programs-where we should be and where 2:40 p.m. we are." Congressman Mike McCormack, 4th Congressional District, Washington, reviews the status of a national energy plan, including organization within the executive branch and in Congress.

3:20 p.m. COFFEE and SOFT DRINKS

(Continued from previous page)

"Energy and Economics." Harry Blundell, Executive Vice President, Utah Power and Light Company, Salt Lake City, explains utility inflation and growth problems and how they relate to the financing of new generating plants. Included is a discussion of the Federal pollution and environmental control requirements.













### REPORT ON PROJECT SUNBURST A DEPARTMENT OF ENERGY COMMERCIAL SOLAR DEMONSTRATION AT RICHLAND, WASHINGTON

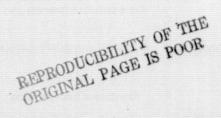
Presented at the Department of Energy Solar Workshop, New Orleans, LA

December 4-7, 1977

Ву

Prepared by: Charles C. Ripley Robert S. Poplin Robert D. Allen

Olympic Engineering Corporation 3070 George Washington Way Richland, Washington 99352



# The Pre-Printed Papers of The Second Solar Heating and Cooling Commercial Demonstration Program Contractors' Review

Hotel del Coronado San Diego, California December 13-15, 1978

November 1978

Sponsored by:
U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Applications
Under Contract No. EC-78-C-01-4131

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A current Olympic Engineering Corporation project for the Department of Energy is the operation and demonstration of a solar space heating, space cooling, and domestic water heating system in our 14,400 square foot Project Sunburst office building at Richland, Washington. The system is designed to provide 71 percent of the space heating, 97 percent of the space cooling, and most of the domestic water heating required for year around operation of the building. An array of 6,000 square feet of roof-mounted ethylene-glycol/ water cooled General Electric flat plate collectors supply energy through a heat exchanger to an underground insulated 9,000 gallon thermal energy storage tank. Hot water is pumped directly from TES to 8 water-to-air coils in the forced air duct work on demand by 8 zone thermostats in the winter. A 25 ton solar hot water driven Arkla absorption chiller cools water in a 2,000 gallon storage tank to supply cold water to the same water-to-air coils in the summer. Final acceptance testing of the solar system was completed in March 1978, and the 50 point D.O.E. data acquisition system was installed in August and operational in September 1978. Comparing the energy consumption of Project Sunburst to an identical non-solar building on the same site showed that were saved in the first 6 months of solar operation. 46,000 kwh

#### DESIGN RATIONALE AND CRITERIA

Preliminary analyses were performed using a mixture of two types of collectors - flat plate and tracking concentrators. This arrangement would result in higher collection temperatures from the concentrators to drive the absorption chiller in the summer. In the winter, the flat plate collectors are needed to utilize the diffuse radiation available during the cloudy heating season. From a cost-effectiveness analysis it was shown that the preferred system is one which uses all flat plate collectors. Data were developed to determine the number of collectors and the size of hot and cold water storage tanks.

Primary source for heating and cooling is the solar system. Back-up is provided by eight heat pumps when solar energy is not available. Solar heating is obtained by pumping hot water from the TES to heating/cooling coils located ahead of the DX (refrigerant) coil in each of the heat pump air handlers. For cooling, chilled water from the solar driven absorption chiller is pumped through the same coils used for heating.

The design configuration selected uses 252 flat plate collectors (6,000 square feet) mounted in 13 rows. A collector tilt angle of 46 from horizontal is specified. A 9,000 gallon tank was designated for hot water storage (T.E.S.) and a 2,000 gallon tank for chilled water storage. The latter tank is incorporated to reduce cycling of the absorption chiller, thereby increasing its operating life. The solar energy system is designed to provide 71 percent of the building space heating, 90 percent of the domestic hot water requirements and 97 percent of the space cooling load.

A unique factor in this project is the involvement of two identical single-story office buildings in Richland, Washington. The buildings, each with a capacity of 100 persons, will have the same external climatographic exposure and nearly identical internal environmental conditions. One building, heated and cooled solely by electrically driven heat pumps, will act as

a control, furnishing electrical energy consumption data for direct comparison with the kwh requirements of the solar heated and cooled building. The own-of the demonstration is Olympic Engineering Corporation. The builder is Development Dynamics Company of Richland, the architect-engineer is The Tracey-Brunstrom-Morgan Partnership of Seattle. The buildings were erected by George Grant Construction of Richland, Washington.

Energy conservation features in the solar building include: dual purpose reflection/evaporation ponds; interior absorption/reflection vertical metal drapes; and recuperation of thermal losses from solar equipment through the demonstration display pipe chase to the return air plenum in heating season and dumping excess hot air outdoors in cooling season. Six inches of glass fiber batt insulation under the roof decks, double glazed windows and vermiculite insulation poured in the hollows of the giant bricks complete the thermal picture for both the control and Project Sunburst building. The control building has bronze tinted glass but the Sunburst building has clear glass to facilitate energy intake off the reflection ponds by the selective drapes in winter. Both buildings have a six foot overhang located on the south side that shades the windows with the amount of shading determined by the solar zenith angle.

The solar and conventional HVAC elements were instrumented in the solar building August 1978 and the data is being transmitted by the D.O.E. Data Acquisition System (DAS). This data will be analyzed by the IBM computer in Huntsville, Alabama to provide a detailed evaluation of the effectiveness of the solar energy installation. No print-outs have been received at Sunburst as of October 10, 1978.

A separate, completely automatic control system is provided for the solar heating and cooling equipment. It has been designed to interface with the controls for the back-up Heat Pumps HVAC system. The control system strategy was designed by General Electric and the control panel was designed and manufactured by G.E.

#### PERFORMANCE ANALYSIS

The building is a single story office building with 14,400 square feet of floor area. Its 180' long dimension lies on a basic east-west orientation. In addition, a cooling pond location around the southern half of the building was designed to reflect insolation into the building during a large portion of the heating season and to serve as the evaporation cooled heat sink for the absorption chiller during the cooling season. The ponds are also the heat sink for the overtemperature control heat exchanger. All south and west windows are clear double glazed and equipped with solar insolation selective reflective/absorptive vertical slat blinds. Six inches of glass fiber batt and aluminized roof coating provide the roof insulation. Vermiculite is poured into the hollows in the giant brick walls.

The building heating loads were calculated using the G.E. Building Transient Thermal Loads Code (BTTL). This code calculates hourly demands by summing conduction heat leaks/gains, infiltration and/or ventilation heat leaks/gains (both sensible and latent), internal heat gains (sensible and latent from occupants, lights, electrical appliances and other internal latent loads) and solar heat gains through windows. The code defines the building in terms of thermal nodes such that each node represents a segment of the physical en-

tity (for example, a layer of wall) and has associated with it a thermal capacity (the product of weight and specific heat) corresponding to the segment represented. Each of the nodes is coupled to adjoining nodes by means of conduction, convection, and radiation couplings, as appropriate. Heat inputs, both steadystate (such as electrical) or time varying (such as solar input) are input to nodes where appropriate. The temperatures of the nodes will change with time in accordance with the various heat inputs and the thermal capacity of each node.

The hourly weather data used in the parametric analysis was obtained from Battelle Pacific Northwest Laboratories' records of climatic data for the Hanford area (vicinity of Richland, Washington). The loads, available insolation together with available roof area, determined the size of the collector array.

#### BUILDING THERMAL MODEL

The building is divided into four rectangular zones, each with the same occupancy and lighting schedules. The two exterior walls of each zone are divided into two nodes per wall with the total "U" coefficient of each specified as 0.18 Btu/hr- $^{\rm O}$ F-ft². Roof insulation beneath the built-up roofing has a "U" coefficient of 0.086 Btu/hr- $^{\rm O}$ F-ft². The final built-up roof coat is aluminized fibrated asphalt.

All windows are of double glazed construction. The eastern and northern exposures have an absorptive coating to reduce the insolation and convective heat transfer. "U" coefficients of 0.36 and 0.56 But/hr-F $^{\rm O}$ -ft $^{\rm Z}$  were used for the coated and non-coated windows respectively.

The building operating schedule in the table below reflects energy conservation features. The room set point temperature will be decreased by  $5^{\circ}F$  in the winter and increased by  $5^{\circ}F$  in the summer during scheduled unoccupied periods to reduce the heating and cooling energy requirements. The external ventilation rate of 1,400 cfm was used to account for door openings.

Building Operating Schedule

Time of Day	0800-1700	1700-1800	Weekends	
Number of People	100	0	0	
Lights, Ft. Candles	100	5	5	
Ventilation and Door Openings, CFM Set Point Temp., <sup>O</sup> F	1,400	0	. 0	
Winter	70	65	65	
Summer	76	81	81	

#### SOLAR SYSTEM DESIGN

#### General Description

The system consists of the following major elements:

- There is a pressurized closed loop, roof mounted, flat plate collector array cooled by circulating 33% ethylene glycol in water. A shell and tube heat exchanger isolates the glycol/water loop from the tap water in the thermal storage and the interconnecting piping to the rest of the system.
- The pumps, heat exchangers, control valves, expansion tanks, filters and air traps are located in a mechanical room beneath the south entrance lobby.
- 3. There are hot water and chilled water thermal energy storage tanks insulated and buried outdoors beneath the south entrance walkway.
- 4. An automatic solar control system senses internal and external conditions and activates or deactivates system modes accordingly. The controls are interfaced with the conventional heat pumps HVAC installation and are designed to utilize solar heat inputs as the prime energy source.

A schematic of the system is shown in the Project Sunburst Schematic & Instrumentation Diagram which follows.

#### Solar Collector Loop

A reverse return manifold design provides an even distribution to east and west banks of collectors, each containing 13 rows varying in length from 8 to 12 collectors. Each row of the the two banks contains a circuit setter valve to facilitate the measurement and balancing of system flow rates. The feeder pipes to the roof mounted headers are routed up through the lobby pipe chase, south, then east and west through the space within the south roof overhang. The return pipes penetrate the north center roof and run south through the plenum over the amenities area and down through the ventilated pipe chase to the solar equipment basement. This pipe chase has a transparent front opening onto the visitor lobby with real time temperature gages on the glycol, hot and cold water coil feed loops and solar domestic hot water pipes. These are incorporated into a pictorial display showing the relationship to the entire system. This pipe chase also is the duct by which waste heat from the solar equipment room is recycled through the air handling system. In summer, waste heat is dumped overboard through a roof hood.

The Solar Energy System Simulation code (SESS) was used to determine the optimum system flow rate of 126 GPM. The onsite D.A.S. readout of flowmeter readings ranged 129-131 GPM on the site readout device on October 1, 1978.

The General Electric FP-2 collectors have an integral inlet manifold at the lower edge of the absorber plate and an integral outlet manifold at the upper edge; they are hydraulically connected by two serpentine passages. Up to twelve collectors can be interconnected at their corners with flexible high temperature (EPDM) hoses to provide a self-headered arrangement. The upper

corner at the inlet end of each row and the lower corner at the outlet end of each row is plugged. The rows are connected to the appropriate high temperature epoxy-glass fiber supply pipes to form a parallel flow distribution system to all the absorber serpentine elements. With manifold pressure drops limited to fifteen percent of the collector  $\Delta P$ , this arrangement results in an acceptable low collector array pressure drop commensurate with maintaining uniform flow distribution of 1/2 GPM per collector.

The EPDM rubber hoses used for collector interconnections serve dual purposes. First, they provide an essentially stress free accommodation for absorber thermal expansions and/or misalignment. Second, since the collectors have electrically isolated absorber plates to prevent direct galvanic couplings, the electrical insulation properties of the hoses are utilized to provide a convenient dielectric type connection. The exterior EPDM hose loops are fastened to the collector nipples with stainless steel worm gear hose clamps. The hose loops and the epoxy-glass fiber supply pipes are insulated with flexible elastomer foam coated with white latex paint for weather protection.

Row by row accelerated flow using circuit setters as aids was used to clear air from the collectors after the initial fill. Normal operating fluid velocity is sufficient to keep the collectors and interconnecting tubing clear of entrained air. Shell and tube heat exchangers of the small tube type were selected because of their availability, economy, efficiency and low thermal mass. They can be readily coupled to any standard tank that may be remotely located and/or buried. Free convection integrally mounted TES coils are comparatively large for high energy rates and require more expensive specialized tank designs and fabrication. In addition to the main heat exchanger transferring energy between the ethylene glycol and the TES tap water, the collector loop includes a second shell and tube heat exchanger which utilizes pumped cooling pond water for system over-temperature control when more energy is collected than can be used or stored within T.E.S. below 210°F. Infrequent panel temperature extremes have occurred when there were power failures and when pump component or system malfunctions have taken place.

#### Energy Storage and Utilization Loops

The solar energy storage loop includes the main heat exchanger, the thermal energy storage tank with a modulating by-pass valve, and the solar domestic hot water heater circuit with an economizer heat exchanger to preheat the solar domestic hot water using heat dumped by the chiller. The utilization loop has a primary pump which takes hot water either directly from main exchanger or TES to supply hot water directly for heating or for driving the ARKLA chiller. Solar cooling is accomplished with an ARKLA absorption water chiller coupled to a chilled water storage tank. This storage tank acts as a thermal capacitor and thereby reduces cycling during low load periods. Storage tanks were located below ground to reduce the size of the solar mechanical basement room.

The solar/conventional HVAC system interface occurs in each of the eight zone heat pump assemblies. A combination solar heating/cooling auxiliary water coil, located in each heat pump air handler, is connected via valves to both the hot and chilled water manifolds. This permits simultaneous solar

heating or cooling in any of the eight zones.

#### Design Assumptions

Number of collectors and type = 252 flat plate FP-2

A/E = 0.94/0.34 Selective Coating

Maximum collector temperature =  $250^{\circ}$  F Maximum ambient temperature =  $110^{\circ}$  F

Collector flow rate = 0.5 gpm/collector

Collector loop fluid = 35% Prestone II/water (by volume)

Collector efficiency = 50%

Specific gravity 35% ethylene

glycol solution =  $0.98 @ 250^{\circ} F$ 

Specific heat 35% ethylene

glycol solution =  $0.94 \text{ Btu/lb.} - ^{\circ}\text{F} @ 250^{\circ} \text{ F}$ 

Maximum solar insolation =  $320 \text{ Btu/ft}^2 \text{ hr.}$ 

#### Performance Evaluation System

Instrumentation was designed to provide indications of absolute temperature and flow rate at each functional energy entrance to the space heating, space cooling and hot water subsystems. Measurements of auxiliary electrical energy supplied to each subsystem are to be made and recorded. There are sufficient flow and temperature measurement to evaluate the interconnecting solar energy transport subsystems and to utilize the energy balance technique on all systems contained in the solar energy system.

The instruments are connected to a centrally located junction box by means of instrumentation grade shielded sensor wires. The J-Box is then connected to a Site Data Acquisition Subsystem which conditions and stores the instrumentation system data for transmission. The data is transmitted thru the telephone data access arrangement to the Central Data Processing Center for the Department of Energy on a call basis.

#### STATUS OF PROJECT AND TECHNICAL PERFORMANCE

The solar building, occupied since January, 1977 was initially operated on its backup heating and cooling system powered by electrically driven heat pumps. Project Sunburst is now complete with collectors, heat exchangers, hot and cold water storage tanks, pumps and ARKLA chiller and most of the insulation on the copper and glass fiber reinforced epoxy piping in place. The heat exchangers in the equipment basement have yet to be insulated. Though the solar system portion was ready for operation to provide space and domestic water heating on December 8, 1977, in fact there were nine continuous weeks of overcast and initial operation was not until Feb. 10, 1978. The operation of the existing circuitry is proceeding without problems. The chilled water system operated first on May 26. The chiller achieved the needed cooling for

the building during the summer of 1978. The collector array has been subjected to wind gusts between 60 and 70 MPH without sustaining any damage.

The system was in full operation from March to September except during a three week period while the temperature sensors of the Site Data Acquisition System, were being installed.

The systems performance has been evaluated only by means of the building electric meter readings comparison since the Data Acquisition System was not installed until August 1978. Final D.A.S checkout was September 1978. System evaluation will be performed from D.A.S. printouts as received from Huntsville.

#### PROBLEMS, SOLUTIONS AND OBSERVATIONS

The flat plate collectors incorporate Lexan windows to eliminate glass breakage. Pumps are strategically located for rapid isolation, removal and replacement. The system can be manually operated by switch overrides. The water systems use sweat-fitted copper pipe to prevent leakage. No insulation problems are known at this time.

The overall system problems have been minimal with respect to such potential malfunctions as coolant leakage, water leakage, pump failure, valve failure, flow stoppage, etc. Of these, only minor leakages were detected at first startup, and these were easily repaired.

During the filling of the collector array the water-ethylene glycol solution was batched in ten 55 gallon increments which are consecutively pumped from the equipment basement upward into the collector array. It is essential to complete the operation and turn on circulating pumps before the coolant boils. The rate of injection was limited by the rate at which the batches were made up and pumped into the system. In the first filling, the coolant overheated with accompanying generation of low pressure steam which could not be released rapidly enough to complete the filling operation. The filling was discontinued and pressure was released by disconnecting appropriate hoses. A second filling was started at 4 a.m. and was successfully completed without incident before solar input became significant.

One source of unexpected expense was the fabrication of fiberglass piping for the solar collector-heat exchanger circuit. This material was specified to electrically isolate the entire array from the building interior and to help prevent galvanic action between aluminun collector passages and connecting pipe runs. Fabrication of circuitry from glass fiber epoxy piping involved more labor because of the craft's unfamiliarity with this type of plumbing technology.

The principal problems encountered in Project Sunburst occurred during installation because of a 30 week strike against all the area contractors by the Pipefitters' Local Union. The strike was not in any way solar related nor did solar work inhibit the final settlement. This long period of inactivity and work-around, however, delayed completion and escalated costs of labor and

Lexan General Electric Co.

material. Remobilization of plumbing contractor crews after the strike cost an additional 6 weeks for Sunburst. In addition, schedular incompatibilities created by this shutdown substantially reduced installation efficiency. This area labor dispute was resolved and no future obstacles are anticipated.

The following operation and maintenance problems have occurred during the period that the system has been in operation:

- o The original installation contained heavy duty EPDM truck radiator hoses for expansion loops in the solar coolant feed piping on the roof. These hoses were found to deteriorate after several months exposure to the heat, glycol fluid and solar radiation. These EPDM expansion loops were replaced by conventional flexible metal bellows braided wire covered loops.
- o The 252 flat plate solar panels selective surface have shown a substantial but not consistent fading. Evaluation of the efficiency of the solar panel coating will be accomplished using D.A.S outputs after all piping insulation has been installed.
- o The solar system with its glycol/water fluid has experienced emergency shut down due to local power outages. During these occurences the pressure relief valve relieved the system overpressure which caused a loss of the glycol/water. A recovery system is to be installed consisting of four drums capable of storing the discharge from the pressure relief valve.
- o An emergency shut down occurred as a result of a glycol/water leak in one of the solar panel connecting manifold tubes in October 1978. The leak was not noticed until mid-day. This loss of fluid plus the solar energy caused a vapor lock to occur in the panels. An attempt was made to refill the system, during the day. The filling was not successful, and the system was vented and drained to roof level. The solar panel which had the failed nipple was replaced and the system reactivated. The failed panel will be repaired by soldering and used as a spare.
- o The flat plate collectors have double glazing of Lexan<sup>(B)</sup>. A few of the inner panels are warping so as to touch the hot absorber. No action is contemplated at present except to observe and report.

Other institutional problems which were resolved have included: 1) Potential jurisdictional dispute over placement of panels, which could have involved plumbers, sheet metal workers and iron workers; plumbers were on the site and did the work, and 2) Interpretation of local building zoning and codes with respect to new solar additions. These were resolved in favor of making the installation as designed.

No problems related to aesthetics or public comments have arisen. Public observations show both curiosity and enthusiasm for the Sunburst demonstration. There is increased public concern about the cost of solar versus time to payback as our savings appear less than anticipated. We expect that savings will improve with: 1) Increased time on the line now that maintenance problems are resolved; 2) D.A.S is installed; allowing the completion of

the pipe and component insulation, and 3) Making control adjustments which we expect to be revealed by initial studies of D.A.S. printouts.

#### PUBLIC VISIBILITY AND IMPACT

The Project Sunburst roof-mounted collector array is clearly visible from adjacent George Washington Way, Richland's principal north-south thoroughfare. About 7,000 vehicles per day carry Hanford commuters and visitors past this demonstration.

Numerous press interviews have been sought by various northwest metropolitan newspapers in addition to the published articles based on press releases. This publicity has been augmented by television and radio interviews. More than fifty invited addresses have been delivered to scientific, engineering and civic organizations in Washington, Oregon, and Idaho. Invited lectures have been presented to audiences ranging from junior high school, Womens' Clubs, and college level to architects and engineers seminars numbering 800 registered attendees.

Project Sunburst has provided a technical foundation for the inception of several significant solar energy projects in the Tri-City and Inland Empire areas. These include the following:

- (a) Domestic and swimming pool water heating and energy recuperation at the Holiday Inn 6-story high-rise addition;
- (b) Design for space and water heating in a 5,500 sq. ft. State of Washington residential facility for the developmentally disabled;
- (c) Domestic and swimming pool water heating at a mobile home community recreational center;
- (d) Winning proposal for a restaurant water heating array for a major office building occupied by Westinghouse Hanford Company;
- (e) Solar energy life-cycle cost study for Eastern Washington State College acquatic center and field house;
- (f) Life cycle cost study for solar water heating for Idaho Falls YMCA swimming pool and building; and
- (g) Energy efficient design and demonstration for insulation, solar water heating and energy recuperation for two private homes.

#### ACKNOWLEDGEMENT

Olympic Engineering Corporation acknowledges the solar heating and cooling system design efforts contributed by Messrs. A.D. Cohen, D.L. Corwin, K. Pater and K. McFarland of the General Electric Vallary Forge Space Center, Philadelphia, PA. This study is summarized in General Electric SD Document No. 76SDS4281, dated January 1977.

